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A STUDY OF THE DEGENERATIVE CHANGES OF THE MENISCI OF THE KNEE JOINT, AND THE CLINICAL SIGNIFICANCE THEREOF*†

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REVIEW OF LITERATURE

Relatively little has been written on the normal and pathological anatomy of the menisci of the knee joint. Mandl, among others, noted that there was definite formation of the menisci as early as the second month of foetal life. The development of the menisci has been studied recently by Dubinkin and Motnenko, who believe, as others have, that the meniscus is derived from the same mesoblastic tissues as the femur and tibia, but that the meniscal tissue becomes less well differentiated than the osseous tissue.

Ishido noted that in the new-born both menisci are broad and cover the entire tibial surface. We have observed the contrary in several babies born prematurely, in whom the menisci had their usual form and position. Mandl also noted that the form and position of the menisci of the new-born are like those of the adult. Both Ishido and he divide the meniscus of the new-born into three layers,—an outer vascular one, a middle zone, rich in fibers, and an inner cellular layer. The blood vessels are rich in the outer zone and penetrate to the middle zone, where the vessels course parallel to the fibers. The middle zone is free of vessels and contains coarse fibers which form an interlacing network. The inner zone is rich in nuclei and contains many cartilage cells arranged in groups, either encapsulated or sometimes with the suggestion of a capsule about them. At the anterior and posterior points of insertion of the menisci, the inner cellular layer is absent and blood vessels penetrate to the inner margin.

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In the first few months of life, it is also pointed out by them, the width of the meniscus regresses, the inner zone diminishes, and the middle zone becomes coarser and more homogeneous. In the second year of life, with the assumption of erect posture and walking, there is a further alteration of structure. The ground substance or substantia of the middle layer shows wavy, interplaiting, homogeneous fibers. There is definite reduction of cell nuclei. The character of fibrocartilage is appearing. There is further reduction of the inner cellular layer and cell nuclei are in nest formation. At twelve to fifteen years of age, the typical appearance of fibrocartilage is present. Ishido noted that at this age there was a misproportion between the narrow blood-vessel lumen and its thick-walled coat, which shows fewer nuclei at this stage, as compared with the normal. The snow-white color of the meniscus of the suckling fades by this time and the meniscus becomes somewhat yellow.

Guibert and Grynfeltt studied the normal meniscus in commenting upon some pathological menisci removed at operation by Estor. They noted that the menisci are triangular on cross section and can be divided into two major layers, parameniscal and meniscal, the latter showing three zones. The parameniscal layer is composed of adipose and connective tissue, through which course vessels and nerves. The meniscal part is composed of fibrocartilage into which vessels from the parameniscal region penetrate radially up to the middle layer. Cartilage cells are most abundant in the middle layer. The inner layer contains no blood vessels.

We know of no particular work on the nerves of the meniscus, though their presence is frequently noted. The relation between pain sensitivity of the meniscus, especially in the locked position of the cartilage, and the presence of meniscal nerve fibers should be investigated.

The meniscus of the old cannot be differentiated from that of the young, according to Mandl. Nor is there any difference in structure between the external and internal menisci, though the former may, according to him, possibly have a larger blood supply. The nuclear richness of a meniscus in a particular period of life is individual and not characteristic of that period.

The work of Tobler on the changes in the menisci with advancing age forms a strong bridge between the normal anatomy of the meniscus and its pathological anatomy. Tobler examined 400 menisci from 100 cadavera of all ages. He described gross degenerative changes as appearing from the second decade on. White, shiny, circular, or spotty areas of "asbestos" degeneration are noted from then on, usually at each end of the meniscus or towards the outer middle part. They may be arranged in stripe formation and run through the entire meniscus lengthwise, and may even be found on the free inner edge. In older people, the white stripes become more yellowish. This "asbestos" degeneration is dependent on a degeneration of the fiber bundles. Irregularity of the free inner edge of the meniscus occurs with advancing age, often without

concomitant joint change. This irregularity may result in very jagged and torn inner edges.

The degenerative changes which occur in the meniscal substance are essentially the degenerative changes which occur in all connective tissues. Fatty infiltration is said by Tobler to occur in sixty-seven per cent. of cases, and begins at the age of fifteen. After the age of thirty-two, all menisci show more or less fatty changes, diffuse or irregularly arranged, and even in single fiber bundles. Cartilage cells undergo fatty changes regularly. Mucoid degeneration is the next most frequent and occurs in fifty per cent. of cases, after the age of sixteen. It is regularly seen after the age of thirty-seven. Mucoid degeneration does not usually express itself in a loosening and swelling of the ground substance, because of the thick and coarse character of the meniscal substance. The cartilage cells may remain intact for a long time in such areas of mucoid degeneration, but these too may be destroyed. Similar changes may often be seen about vessels in the parameniscal tissues. "Asbestos" degeneration also occurs and expresses itself in fine fibrillation of the fibers, which become necrotic by molecular destruction. Hyalinization of the ground substance is present in thirty per cent. of all cases and is found mostly in the middle zone, though it may also be seen in the torn, frayed edge of the meniscus. Calcification is a secondary change and was observed in fifteen per cent. of the cases, the youngest specimen occurring in a cadaver sixteen years of age. The calcium is deposited as a fine dust at the site of a previously formed area of mucoid or "asbestos" degeneration.

Other less important changes may occur. There may be overgrowth of cartilage cells, encapsulated or free, in diffuse or irregular masses. Oedema of the fiber bundles may occur in the inner middle zone near the insertion point of the meniscus. There may be a transition to hyaline cartilage, or even metaplasia to bone-like tissue. Elastic fibers in the fibrocartilage are few and may degenerate to fibrous tissue.

Pure degeneration is seldom seen after the age of seventy, according to Tobler. Predilection for degeneration occurs at the anterior and posterior insertion points, and in the arched middle, in the transition from the middle to the outer zone. These degenerative changes were also observed in operatively removed menisci, both in cases with and in those without a history of trauma. There may be a high degree of degeneration in a meniscus which has manifested few symptoms clinically.

Bircher examined seventy-four menisci of cadavera histologically, of which thirty were normal and forty were altered. The table of alterations cited by him follows:

24 showed arthritic changes.
15 showed new blood-vessel formation.
14 showed swelling and opacity.
8 showed infiltration.
8 showed necrosis.
9 showed meniscitis.

5 showed cell poverty.
4 showed nuclear poverty.
4 showed hyaline change.
3 showed poverty in blood vessels.
2 showed "asbestos" change.

A comparative series of 100 menisci operatively removed showed that more than one-half had undergone some degenerative change. The table follows:

1.	No histological change	29 per cent.
2.	Tears	23 per cent.
3.	Connective-tissue change of cartilage	24 per cent.
4.	Overgrowth of connective tissue	8 per cent.
5.	Increase of cells of fibrocartilage	6 per cent.
6.	Early organization	1 per cent.
7.	Fibrin deposits	5 per cent.
8.	Softening of cartilage and loss of nuclear staining	21 per cent.
9.	Increase of fibroblasts	10 per cent.
10.	Mucoid degeneration of cartilage	2 per cent.
11.	Fibrinoid change	6 per cent.
12.	Inflammation	5 per cent.
13.	Increase of new blood vessels and new blood-vessel formation	22 per cent.
14.	Fresh hemorrhage	8 per cent.
15.	Hemosiderin deposits	23 per cent.
16.	Calcification	3 per cent.

These changes are merely itemized in his work and not correlated.

Mandl examined thirty-eight of fifty-two operatively removed menisci. Of these, fifteen showed no disease process and twenty-three did. The author emphasizes that the pathological changes which he describes were never found in cadaver material, comparatively examined. A summary of the changes found in the twenty-three pathological menisci examined follows:

1. A round-cell infiltration about the vessels, the extent of this infiltration varying. The vessels were not limited to the outer layer, but penetrated even as far as the central layer.

2. Extensive areas of poor staining of the ground substance with absence of nuclei. This is most marked in the middle layer and is considered by him as an atrophic or necrotic process.

3. The presence of circumscribed or diffuse calcification of the ground substance as a degenerative change of high degree. This may occur either in the ground substance, usually as a fine dust, or in the capsule of cartilage cells, or in both.

4. Oedematous swelling of the ground substance.

Mandl arrives at the very fundamental conclusion that in cases in which there is a definite history of trauma there are no demonstrable pathological changes in the meniscus; and that in cases in which there is a history of no trauma, demonstrable changes are present. In the course of this work, we shall refute this statement.

Twelve out of thirteen operatively removed menisci, all with antecedent trauma, showed pathological changes, according to Thomsen of Kiel. He also pointed out the following histological findings in menisci which he examined,—round-cell infiltration with increase of capillaries and new fibroblastic growth, the formation of cystic spaces without endothelium, areas of ground substance in which no or few nuclei were present, areas of calcification, beginning and progressive fatty degeneration, and, finally, dissolving or breaking up of the capsules of cartilage cells. Baetzner, in two cases, noted marked degeneration of the ground substance, in part associated with fibrillation. There was also noted an increase in cells about increased and thickened blood vessels. An increase in long, spindle-shaped cells, closely packed together, was seen

Röllgen examined menisci removed from young sportsmen and believes that meniscal tears are dependent on previous degenerative changes in the meniscus. He also noted certain changes in the vessels, consisting essentially of increase in number and of thickening of their walls. This was most marked at either end. In two cases, ossification of the meniscal ground substance occurred in part and true bone tissue was present. This must be a most unusual thing in man, since we have no record of any other such cases, save that of Lardys.* Fisher noted that in marked mobility of the posterior end of the meniscus, marked hypertrophy and ossification might take place. In two cases, there was a metaplasia of the degenerated ground substance into hyaline cartilage. This also is an unusual change, distinguished not so much by its improbability as by its rarity. Röllgen suggests that possibly excessive demands on the knee, not necessarily of one great trauma but of repeated traumata, may lead to meniscal degeneration. He also suggests that changes in the blood vessels or changes in the synovial fluid may lead to degeneration.

Calcification of the meniscus is occasionally recognized by x-ray. Few cases have been reported and the situation is comparable to the occasional roentgenographic reports of calcinosis intervertebralis, before the work of Schmorl threw a panoramic vista on the pathology of the intervertebral discs. Calcification of the meniscus is secondary always to previous degeneration. Little calcification is seen usually, even in widespread degeneration. Israelski notes that calcification is usually bilateral, occurs past middle life, is unassociated with trauma and with arthritis deformans. About six cases have been reported, according to him. He quotes the findings in one case in which the cartilage was removed. A loss of cartilage cells with an excess of fibrous tissue and a diffuse infiltration with calcium was noted. One patient had gout and another

* It seems not at all to be known that bone may be present as a normal constituent of the menisci of certain animals. Dr. Henry L. Jaffe recently demonstrated this fact before the New York Pathological Society. He showed that bone develops normally in the menisci of mice, guinea-pigs, and rats. His presentation may be found in the December 1932 Proceedings of the New York Pathological Society, published in *Archives of Pathology*, XV, 599, Apr. 1933.

diabetes; hence, Israelski believes in a metabolic significance of this condition. Symptoms may or may not be present. Werwarth, Bruchholz, Schwarz, and Meyer-Borstel have also reported cases, and the latter believes the process analogous to a beginning, ankylosing spondylarthritis.

Regeneration of the experimentally and clinically extirpated meniscus has been reported. Pfab noted the regeneration of the meniscus in sheep and in rabbits. The meniscus is reconstructed in the sheep in six months and in rabbits the process of regeneration has begun at six weeks. The meniscus is reconstructed from a synovial outgrowth between the femur and tibia, and, in one case in which its structure was examined histologically, it was found to consist of a thick, collagenous, connective tissue, fairly rich in blood vessels. Changes in the articular cartilage may accompany this regeneration in rabbits.

Sir Robert Jones noted that usually no trace of any new meniscal structure is found, even ten years after operation. Yet, in one case, three years after the removal of the meniscus for bucket-handle fracture, an almost normal meniscus was found on reoperation, the second operation being for loose body in the joint. If priority is to be given for the discovery of meniscal regeneration, he should receive it, since his observation precedes that of Mandl. Mandl noted this regeneration of the meniscus in four cases, in three of which reoperation was necessary for another condition and in one *post mortem*. That this regeneration of the meniscus is not necessarily advantageous is confirmed by the experience of Möller, who removed a regenerated meniscus which had become luxated. The new meniscus was a structure three to four millimeters broad, looked like a meniscus, was as hard as cartilage, and was properly placed. Microscopically, it consisted of a half sclerotic, lamellar, connective tissue, with vital nuclei. No sign of true cartilaginous tissue was present.

It may be the experience of a surgeon to find a meniscus *in situ* which had apparently been previously removed. Thus Fisher, who advocates the large exposure of the knee joint in operating for internal derangement of the knee, in one particular case noted that both menisci, previously considered removed through the usual small incision, were still present. This most probably is an instance of regeneration. Gibson comments on a similar experience.

Dieterich, Friedrich, Lukjanov and Pokrovski have also made clinical and experimental contributions on meniscal regeneration.

THE CLINICAL CORRELATION

Ishido committed a fallacy in asserting that the meniscal fibrocartilage takes part in diseases affecting the body proper,—such as uraemia, leukaemia, and endocarditis lenta. The changes described are simply the degenerative changes of progressive age, a fact which had not then been brought out. It is quite possible that in general septic processes the meniscus may be involved by metastasis. Thus he noted

purulent inflammation in the synovial part of the meniscus in thrombophlebitis, in grippe empyema, etc. There was purulent infiltration of the meniscus in a man, twenty-nine years old, dead of general sepsis, arising from a furuncle. Mandl noted extensive meniscal changes in diabetes, consisting of fibrillation of the ground substance, increase in vessels and cell nuclei, swelling of cartilage cells, and overgrowth of synovia. Again, before these changes are accepted as specific diabetic changes in the meniscus or even as a manifestation of a general diabetic change, the ever present factor of time degeneration must be ruled out.

More interesting is the observation of Ishido that in a woman of sixty-four, dead of arteriosclerosis, there was a marked degeneration of the ground substance and marked arteriosclerosis of the meniscal vessels. Henschen noted that meniscal vessels participated in diabetic vascular changes, indicating that these vessels might participate in severe sclerotic and degenerative changes of blood vessels.

Ohta noted that, after removal of the presacral ganglion, degeneration occurred in the meniscus.

The meniscus also, according to Ishido, was affected in joint changes. Thus he describes secondary degenerative changes of the meniscus in a joint affected with severe arthritis deformans, associated with tabes dorsalis. The severity of meniscal change corresponded to the severity of change on the femur surface. Heine, in an extensive monograph on arthritis, noted very briefly that the menisci and the crucial ligaments could also be involved by fibrillation and fragmentation. Müller pointed out that softening of cartilage takes place at points of pressure, where menisci or other intra-articular structures are placed. It is then quite possible that the effects of pressure on one will produce changes in the other. Fisher shows a meniscus involved in osteo-arthritis of the knee in which the posterior part of the meniscus is broadened and frayed Mandl noted that, since the medial condyle of the femur is the most frequent site of arthritis of the knee, it is possible to see how changes in the internal meniscus might occur. Läwen has also observed this and has noted degeneration of the meniscus in primary chondropathy of the patella. In general, it may be said that there is a greater or lesser belief that meniscal changes may occur in arthritis.

We will not discuss inflammatory meniscal changes due to an associated joint lesion,—as tuberculosis, pyarthrosis, etc.

A condition which has attracted attention in France and Switzerland is the so called "traumatic meniscitis" of Roux. This was first described by Roux in 1895 and again in 1926, as a circumscribed thickening and inflammation of the outer and lower parts of the meniscal tissues, in the region of the lateral ligament, reaching to the anterior horn of the meniscus. This inflammation might pass over into the fat pads and produce Hoffa's disease as an end result. It is said to be really not an actual inflammation of meniscal substance itself, since it is a parameniscal inflammation, manifesting itself clinically as a meniscal lesion. It is

readily healed by conservative treatment, if no active lesion is present. According to Fisher, a thickened or fibrous semilunar fat pad may become attached to the meniscus by adhesions, the meniscus itself either being normal or showing changes. A contusion of the outer part of the meniscus, resulting in hemorrhage, may also occur. These changes may possibly be considered akin to the meniscitis of Roux.

Roux's syndrome, if it actually exists, has not received great support, since its character is indefinite. Many authors,—such as Pouzet, Bonnet, Philipoff, Steinmann, Estor, Patel, and Judet—have observed inflammatory changes in the meniscus. Bircher doubted whether the so called inflammatory changes deserved to be called "meniscitis", and reserved the term for those cases which showed actual inflammatory changes. Estor believed in a meniscitis on a non-traumatic basis and likened the meniscus to the avascular cornea as a seat of inflammation. Fründ was inclined to believe that small thickenings in removed menisci were inflammatory in origin. Najdanowitsch speaks of a true perimeniscitis. Mouchet and Tavernier, and Willems contest the definite presence of meniscitis.

A summary of the literature has indicated that the pathological anatomy of the menisci of the knee joint is a relatively unexplored field. This is surprising in view of the fact that meniscectomy is a standard procedure. The menisci of the knee joint, then, tend to undergo degeneration of various types. This degeneration is apparently greater with advancing age. The blood supply of the menisci is poor. Little attention has been given to changes in the blood supply of the menisci. Tobler and Ishido noted that vessel walls are relatively thick. A few observers have commented upon changes in the vessels.

GROSS EXAMINATION OF 200 MENISCI REMOVED FROM CADAVERA, OF WHICH 50 WERE EXAMINED MICROSCOPICALLY

Two hundred menisci from seventy-six cadavera were studied grossly. In all of these cases death was due to causes unassociated with primary joint disease, and, while it would not be fair to assume that no meniscal symptoms were present in life, still none of these cadavera presented any signs of previous operative interference in or about the knee joint. The menisci will be described by decade groups. The following table gives an analytic distribution of the specimens. In some cadavera, four menisci were removed; in others, three, two, or only one.

TABLE I

First decade	10 cadavera	26 menisci
Second decade	1 cadaver	2 menisci
Third decade	9 cadavera	25 menisci
Fourth decade	9 cadavera	27 menisci
Fifth decade	6 cadavera	14 menisci
Sixth decade	13 cadavera	34 menisci
Seventh decade	15 cadavera	39 menisci
Eighth decade	12 cadavera	30 menisci
Ninth decade	1 cadaver	3 menisci

It will be noted that more than half of the menisci examined are in the age groups of fifty to ninety years. This, however, will be counterbalanced by a study of the operatively removed menisci, in which the predominant age groups are from ten to forty years.

In the first decade of life, the menisci of three premature babies were examined, and showed normal form and position. Two full-term babies, a child of five months, and four children from two to six years of age were also examined. In all, the menisci were glistening, snowy white, smooth on both their upper (femoral) and lower (tibial) surfaces. The inner free edge was smooth and regular, and was slightly translucent. There was no gross sign of degeneration.

The one case in the second decade of life, a child of fifteen, showed a similar type of meniscus.

In the third decade, changes begin to appear. The external menisci of both knees, in an acromegalic cadaver, were abnormal in size and shape. The menisci were larger than normal and covered almost the entire lateral condyle of the tibia. The inner edge did not taper, but was pinkish, thick, and rolled up on itself, so that section of the meniscus was not triangular but oblong. There was a small projection from the rolled-up inner edge, near its center. The external meniscus tended to keep its C-shape. Interestingly enough, this peculiar meniscus was first observed through the arthroscope, before the joint was opened. The internal menisci of these knees were normal, though the inner edge of each was slightly irregular. Of the other menisci in this age group, it was noted that one meniscus showed a yellowing of its color, a change which becomes more frequent with advancing age. One meniscus showed marked fibrosis and "asbestos" degeneration of its ground substance. Thus, most of the twenty-five menisci were still normal grossly.

In the fourth decade, sixteen menisci were considered normal and eleven showed changes. The earliest change is one in color, a yellow or yellow brown being added to the normal white of the meniscus. There then appears a slight irregularity of the inner free edge, with diminution in its translucency. This irregularity may become a definite fraying. The surface of the meniscus becomes less smooth, even fuzzy and fibrillar, usually first on its upper or femoral surface. "Asbestos" change of varying degree may supervene and is indicated by the presence of silvery spots or stripes, usually at either end of the meniscus, or, at times, in the outer central portion. These changes were present in varying degree in the eleven menisci considered abnormal. Only one showed marked "asbestos" degeneration. This sequence of events in the alteration of a meniscus holds true for all other decades, though the changes occur in more marked degree.

In the fifth decade, the progression of degeneration continues. Of the fourteen menisci examined, two were normal; eight showed mild degenerative changes; and four showed marked alterations in appearance.

From the sixth decade on through the ninth decade, one no longer

sees menisci which may be considered normal, as compared with the early decades. In the sixth decade, mild changes were noted in eleven and advanced changes in twenty-three; in the seventh decade, slight changes were seen in six and more advanced alterations in thirty-three. In the eighth decade, advanced changes were seen in the thirty menisci examined. This was also true of the three menisci examined in the ninth decade. Arthritis of the knee occurs in increasing frequency in the periods just noted. In general, it may be stated from a study of nine definitely arthritic cadavera in this series that the degenerative changes run parallel to the degree of arthritis. There may be severe degeneration of the meniscus in the absence of arthritis or there may be severe arthritic changes in the presence of mild degenerative changes in the meniscus.

"Asbestos" degeneration becomes more marked in the later decades of life, so that in the severest cases the meniscus is merely a fold of silvery scar tissue interposed between the joint surfaces. This was noted very definitely once. Or the "asbestos" degeneration may be so marked at one end of the meniscus that it may become flattened, broadened, and loosened,—so much so that a foreign body might easily slip under the meniscus. Clinically, the slipping of a joint mouse under the meniscus has been reported by Geist. In no cases were fractures of the meniscal substance, either traumatic or pathological, observed, despite the very evident severe degeneration of many of these menisci. Joint mice were never noted, and in no case was a deposit of fibrin or blood noted on the meniscal surface.

Both the external and internal meniscus respond equally to the degenerative changes noted, and the greater frequency of injuries of the internal meniscus clinically can not be laid to this source. These pictures of advanced degeneration have been seldom noted in the living patient, since most of the operated cases fall in the younger groups. It may be possible, on gross examination, to place an excised meniscus in a particular period of life, though with no great exactitude.

MICROSCOPIC CHANGES IN THE MENISCI EXAMINED

Fifty of the menisci were examined microscopically and ten of these were stained with Mallory's elastic-tissue stain. Unfortunately, in the course of transportation and long storage of the specimens, after they had been grossly classified and described, there was a mix-up of the specimens, so that it was not possible to assign these menisci to their proper decade groups for microscopic examination. However, from their gross appearance, most of the specimens belonged to the later age groups. A few menisci of babies were included, as were also a few menisci in the earlier age groups. The menisci of babies will not be discussed in this paper.

All of the menisci showed degeneration of varying degree, both those that appeared grossly normal and the abnormal. Hyaline degeneration of the ground substance was most frequent. Oedema of the ground substance

was common in those menisci showing marked gross changes. Mucoid degeneration was also observed. The blood vessels in the vascular zone of the meniscus presented frequent alterations.

In order to simplify the description of pathological changes with regard to localization, two major meniscal zones are made out,—an outer vascular zone, and an inner avascular zone.

The blood vessels in the vascular zone presented many interesting appearances. Only the smaller vessels and capillaries usually showed changes and any large vessels that were seen were usually normal, though somewhat thick-walled. Occasionally the larger vessels also showed deviations from the normal. Hyalinization of the vessel walls of the small vessels and capillaries with frequent consequent fibrosis was seen fairly often. Thrombosis of the small vessels with organization was uncommonly observed. An eccentric intimal thickening was observed at times in the smaller, and occasionally in the larger vessels. The smooth intimal lining was seldom eroded or ulcerated. Elastic tissue was not demonstrable by ordinary stain. The Mallory elastic-tissue stain showed fragmentation of the inner elastic layer in the larger vessels at times. No elastic tissue was demonstrated in the smaller vessels. Vacuolization of the cells of the intima and of the middle coat was sometimes seen. No calcification of vessel wall was noted. An aggregation of small lymphocytes in the region of a vessel was seldom seen. Plasma cells were very rarely present. No evidence of inflammation was seen in any of the menisci examined.

Two major changes were noted in the ground substance of the menisci examined: oedema of the ground substance, expressing itself in fine fibrillation and loosening of the substantia; and, secondly, hyalinization of the ground substance. These two degenerative changes went hand in hand. This dissolving of the matrix by oedema was most marked in the interior of the meniscus. Small and great gaps were thus sometimes formed in the substantia, appearing as irregular intrameniscal cysts without lining. These spaces rarely resembled true cysts, for they were lined by smooth meniscal fibers in which flattened fibroblasts and cartilage cells were seen. These cystic spaces are not revealed by gross examination and Mandl has termed them intrameniscal cysts. The periphery of the meniscus was less degenerated and this was due to the anatomical arrangement of the fibers. The peripheral fibers run parallel to the synovial border and are gathered fairly thickly. As the interior of the meniscus is reached, obliquely running fibers are noted connecting bundles cut either transversely or longitudinally, forming a looser mesh than at the periphery. The external configuration of the meniscus need not be disturbed by extensive degeneration within its substance. The junction of the avascular and vascular areas was also the site of great fragmentation of the ground substance.

Mucoid degeneration was seen fairly frequently. Calcification of the ground substance was rare, and was always small and scattered.

There was no tendency to organize the degenerating areas, although near the area of synovial reflection a small invasion of fibroblasts and vessels occasionally took place.

In the outer vascular zone there was seen a variable amount of fat surrounding blood vessels and cross-cut fibers of the ground substance. Fat was not seen in the inner zone in any specimen.

As the synovial lining of the meniscus is continued over both surfaces of the meniscus, it loses its cellular quality and becomes a narrow, faintly staining, pinkish membrane, which shows faint traces of cellular structure. The point of transition into a single flat layer occurs at the level of synovial reflection. The membrane was often torn, irregular, and jagged. A deposit of fibrin or mucin on its surface was uncommonly seen and only once was a small hemorrhage noted. Cellular débris was not uncommonly seen on its surface.

Cartilage cells, normally usually arranged in small groups, lost their group arrangement by disintegration of their constituent cells in areas of degeneration. Nothing was left at times of the original cartilage cell. The fusion of spaces originally occupied by cartilage cells created small, irregular, cyst-like areas. This degeneration of cartilage cells was often wide-spread and was most pronounced in the middle of the avascular zone. No regeneration of cartilage cells, and no regional hypertrophy of cells, expressed by increased nest formation, was seen.

A MICROSCOPIC STUDY OF 85 SURGICALLY REMOVED MENISCI

Microscopic examination was made of the menisci of eighty-five patients in varying age groups. Surgical removal of the internal or external meniscus, or both, was done by various members of the staff of the Hospital for Joint Diseases. Decade distribution of cases is tabulated.

TABLE II

Decade	*Cases*	*Male*	*Female*	*Trauma*	*No Trauma*
Second	17	11	6	16	1
Third	31	22	9	29	1 (and 1 with questionable onset)
Fourth	20	13	7	18	2
Fifth	11	8	3	9	2
Sixth	4	2	2	2	2
Seventh	2	1	1	2	0

The changes which were observed were again degenerative, though it was noted that mucoid degeneration was present to a larger degree than oedema of the ground substance, as compared with the cadaver material. Degeneration in a particular case was never pure.

The earliest change which took place was degeneration of the ground substance in the middle of the avascular zone of the meniscus. The subsynovial fibers, peripherally located, remained normal longest. Mucoid change, detected by its characteristic reaction, usually did not

result in the formation of clear, mucoid spaces. Cartilage cells often retained their form in an area of mucoid degeneration. Mucin was noted at times on the surface of the cartilage. The presence of mucoid areas in the outer vascular part occurred concurrently with that in the avascular parts. The significance of mucoid degeneration of the ground substance will be discussed more fully in the pathogenesis of meniscal cysts.

Oedema of the ground substance was less frequent and less extensive and was usually localized. Hyalinization of the ground substance occurred very frequently and was often accompanied by nuclear death, with fragmentation and pyknosis of nuclei. Anaemic necrosis of the ground substance was relatively common in the avascular zone. It was always combined with other changes.

The ground substance seldom underwent such extreme fragmentation and vacuolization that intrameniscal cysts were formed.

Fragmentation of the inner edge of the meniscus occurred often, so that it became irregular. At times, polypoid formation of the inner edge was present. The synovial layer over the meniscus was often broken up and in no case presented well defined cells. The synovial layer was narrow and usually hyalinized, though very seldom it extended as a cellular layer with subsynovial capillaries over the outer two-thirds of the meniscus. The débris on the surface of the meniscus consisted of cellular detritus, red cells, and small lymphocytes at times. Occasionally, an area of hemorrhage was noted in the ground substance or on the surface of the meniscus.

The cells in the matrix presented various changes. They might remain unaltered in the presence of a frankly degenerated or necrotic area. The cells which preserved their vitality the longest were those at the apex of the cross-cut meniscus and those at the periphery. Cells occasionally were clustered in nests, usually in groups of four to eight. Large clusters of cells were not observed. Nuclear death and the loss of cell and capsule occurred at times in areas of necrosis and degeneration. The fusion of many spaces created by the washing out of cells and capsules resulted in small intrameniscal spaces.

The point of greatest weakness in the meniscus was the junction of the vascular and avascular parts. Fragmentation may be so marked here that there may be separation of the two parts from each other.

The outer vascular layer presented a varying amount of cross-cut meniscal fibers, which underwent a lesser degeneration.

A few unusual observations were also noted. In a man in whom the internal meniscus had been previously removed, a pennant-shaped structure was seen at the site of the removed meniscus by arthroscopy and by arthrotomy. This may have been a regenerating meniscus, though we cannot be too certain of this. In another case, a hard calcified mass had developed at the site of the removed meniscus, in intimate contact with the tibia. This was noted at reoperation, when, in attempting to remove the posterior remaining fragment of the meniscus, it was found to end in this

mass of calcified tissue. Another meniscus is said to have been congested at its inner border; this must be considered a most unusual observation, since the meniscus is absolutely avascular at this point. Microscopic examination of this meniscus showed no signs of congestion.

The synovia showed frequent changes, consisting of hyperplasia of varying degree, congestion of subsynovial capillaries with a varying amount of lymphocytic infiltration, and occasional vessel alteration, as hyalinization.

The blood vessels of the meniscus again presented changes, similar to those seen in the cadaver specimens. Capillaries and small arterioles were primarily affected; the larger vessels were only occasionally involved. A focal collection of small lymphocytes was rarely seen about the vessels. Plasma cells were observed once or twice. A hemorrhage was seldom seen. About some capillaries there occasionally occurred a loose, concentric collection of young fibroblasts. The vessels in the removed infrapatellar fat pad often showed the same changes.

These vessel changes were present at all ages and were even noted in marked degree in the meniscus of a boy of ten. Regressive vessel changes are often found in certain organs such as the uterus and spleen. Yet, it must not be forgotten that these are organs of great vascularity and a disturbance of part of their blood supply does not affect the organ greatly. The meniscus, on the other hand, is relatively avascular and these vessel changes may be sufficient to disturb it. We do not mean to infer that the vessel changes are the direct cause of meniscal degeneration. These vessel changes are usually present in the presence of degeneration, though this is not always so. In general, the degree of vascular change runs parallel with the degree of meniscal degenerative change. Occasionally, vessel changes exceed the degenerative changes. The fibrosis and hyalinization of the vessels is evidently a regional phenomenon, since it often takes place in individuals otherwise healthy as regards the vascular system. It may of course participate in extensive, general, vascular change, and this was noted by Ishido and Henschen. In one of our cases, a patient in the seventh decade group, Mönckeberg's medial sclerosis was noted in a large meniscal vessel.

The vessels are intimately related to the process of repair in a meniscal fracture. Many fractures must undoubtedly occur with subclinical symptoms; or, with recurrence of locking and pain, a new fracture is created, macroscopic or microscopic, which may be healed by scar tissue if removal of the meniscus is not done. The healing, to be exact, is usually present in the vascular zone and in the outer avascular zone. Vessels never penetrate deeply into the ground substance. The capacity for healing of the meniscus is limited and this is often proven clinically. Fisher has demonstrated this experimentally. Yet, exsection of a limited piece of meniscus may result in regeneration, as shown by Dieterich. Healing occurs by the invasion into a fractured area of newly formed capillaries and young fibroblasts, which extend cord-like or stripe-like into

the gap. Maturity of vessels and cells takes place and scar tissue is formed, which is slightly vascular. The vessels in an area of such repair may undergo extensive thickening and hyalinization.

These degenerative changes of the meniscus are then present at all ages. It seems to us that the term "*meniscosis*" expresses best these degenerative changes, rather than the indefinite "meniscopathy".

One cannot place a meniscus in a definite age period by microscopic examination of a particular meniscus. Practically all menisci examined showed degeneration; only one or two did not. We also agree with Mandl that the nuclear content of the meniscus is individual. The amount of degeneration usually runs parallel with the duration of symptoms and questionably with the number of recurrences. It cannot be taken for granted, however, that degeneration begins with the original trauma. Thus, a meniscus with a very brief period of trauma may show advanced changes, even at so early an age as ten; or a meniscus, subjected to trauma of three years' duration and more than eighty attacks of locking, may remain relatively normal. It is quite probable that the degenerative changes in the meniscus are entirely independent of the original acute trauma, although degeneration may be hastened by it. Again, the stage of repair in a meniscus may be older than the clinical history, indicating previous subclinical fracture. The detached fragments of the meniscus, as in a bucket-handle fracture, often show degeneration, and these should not be neglected in the study of the meniscus.

It is interesting to speculate just why degeneration is so frequent in the menisci of the knee and apparently so rare in similar fibrocartilages,—such as the intra-articular meniscus of the temporomandibular joint. We examined the surgically removed meniscus of the jaw in one case; it was normal in structure. Baecker has recently examined the menisci of the jaw in six cases, and despite the relative avascularity of the tissue, normal cells and fibers were present, even in the old. Little has been written on this and further study should be carried on. Weight-bearing must condition meniscal degeneration, since this degeneration is also noted so commonly in the intervertebral discs. These are also composed of white fibrocartilage which regularly regresses with advancing age.

Meniscitis is never present. It is true that occasionally small round-cell infiltration is present about the smaller vessels, but this is never extensive and is confined to the outer part of the vascular zone. The synovial lining and the fat pads do show a true inflammation and, probably, the slight infiltrations noted in the meniscus are extensions of the synovial process. Meniscitis does not exist as a primary entity and the conception of Roux, unsupported by clinical or microscopic evidence, cannot be accepted.

THE PATHOGENESIS OF MENISCAL CYSTS

Meniscal cysts, once considered rare, are being reported with increasing frequency. From a review of the literature and a detailed

microscopic study of eight cases, we believe that meniscal cysts are degenerative in origin.

Two cases in the fourth decade of life showed a somewhat different anatomical association than is usual with meniscal cysts. One was a yellow, irregular tumor, placed under the biceps femoris tendon, surrounding the external lateral ligament of the knee joint. It was definitely connected with the external meniscus. From its yellow color and irregular shape, an operative diagnosis of xanthoma was made. The tumor and a portion of the meniscus were resected. Microscopically, this tumor was definitely a cyst. The other case in this age group presented intimate association of the cyst with the external lateral ligament.

The youngest patient in this series was eleven years old and the oldest thirty-nine. Most belonged in the usual age group of twenty-five to thirty years. Of the eight cases, six were cysts of the external meniscus and two of the internal meniscus. Of the latter, one has been previously reported by Zadek and Jaffe.

The gross characteristics of meniscal cysts will not be described, since they have been so well described by other authors. That type of cyst which is definitely parameniscal must be considered in a separate group. Fisher has pointed out that a bursa may sometimes be present at the anterior edge of the internal lateral ligament, in close connection with the internal meniscus, and that this bursa is a more common finding in anthropoid apes. Sir Robert Jones, in a footnote on this observation, said that he had removed two such cysts clinically and that they were not attached to the meniscus. Small cystic spaces are occasionally found in the parameniscal tissues, according to Jaffe, and it is possible that larger, palpable cysts may originate from them.

In the literature on meniscal cysts, two cases have been reported which are definitely parameniscal cysts. The first case of Zäch-Christen was of a cyst in definite connection with the external meniscus but easily shelled out from it. A meniscal cyst is a cyst which is an integral part of the meniscus and cannot be shelled out properly from the meniscus. In this case, the meniscus was left untouched. Microscopically, the cyst consisted of smaller cysts of various sizes, sharply outlined or not clearly demarcated, and lined by connective tissue. The second case was that of Krapf, who also described a small tumor placed between the external lateral ligament and the ligamentum capitis fibulae, definitely adherent to the joint capsule, but not to the external meniscus. The tumor was easily removed and the external meniscus was left intact. The tumor consisted of connective tissue, much like that of meniscal fibrocartilage, in which mucoid changes were taking place. The connective tissue as yet greatly exceeded the cystic, mucoid areas.

The microscopic feature of any meniscal cyst is a focal area of mucoid degeneration, which is the progenitor of the cyst. This has been well shown by King in his excellent paper. These cysts arise as circumscribed areas of mucoid degeneration, both in the avascular part of the meniscus

and in the vascular part. This change is, of course, greatest in the vascular zone. Focal oedema plays a part, albeit a minor one. In the inner avascular zone, the mucoid changes are less loose, more diffuse and adhesive, and there is less often the tendency to focal formation, though this, however, does occur. The outer avascular zone often shows large cystic spaces due to the inward spread of the cyst from the vascular zone. The fact that this mucoid change takes place is not unusual, since it is a frequent form of degeneration in the meniscus. The motions of the femoral condyles will not allow the formation of cysts of appreciable size in the inner avascular zone, since pressure tends to squeeze all mucoid areas outward and toward the center of the meniscus. This explains the typical location of the cysts in the external meniscus. The larger formation of cysts in the vascular zone is due to the looser character of the tissue, which allows cystic expansion. Mucoid changes, never uncommon in the vascular zone, are of a looser, less adhesive character. It is not necessary to assume that this mucoid change is a secretory phenomenon. In a tissue in which mucoid change is regularly seen, it is unnecessary to assume specific functions of secretion as the cause of cyst formation.

The confluence of small cysts creates larger ones. Septa are found in a large cyst, indicating the lines of division of its constituent smaller cysts. The cysts may be distended or collapsed and, when large, contain usually only a mucoid débris in which no cellular structure is visible. The smaller cysts often show a myxomatous content, in part or in whole. Few typical, branching star cells are present.

The walls of the cysts are never endothelial. They are always formed of meniscal fibers, sometimes so altered that a smooth lining is formed. In the larger cysts, the walls are smooth and are formed by flattened and compressed meniscal fibers, in which spindle-shaped fibroblasts may be seen. These cells are not necessarily on the surface of the cyst, and King has proven this definitely by the use of silver stains which stain meniscal fibers but not endothelium. The cells lining the cyst may become so flat that a lining which superficially resembles endothelium is formed. This lining is never complete. The lining of the cyst may become a hyalinized membrane, staining a light pink, in which no cells are found. This has also been seen by Zäch-Christen. Or there may be an increase of cells at some particular point in the lining, so that a layer of cells, two to three deep, may be formed. The outer cells of these are always typically fibroblasts, and as the inner cells are approached, they become rounder or more oval. Villous processes may project into the cysts but these are never typical synovial villi. They are solid, cord-like, relatively avascular, and partially divide the cyst. The cells of these villi are essentially those round or oval cells described above. They form a smooth lining on the surface. Venezian depicted one such villus in an illustration accompanying his paper. A dissecting process of the meniscal fibers may be noted about the cysts, due to either mucoid or

oedematous change. This is a method of cyst progression and is not uncommon. It is a surprising thing to find many normal meniscal fibers about the cysts, so that a cursory examination might lead one to expect slight changes of the meniscal ground substance.

Marked degeneration of the ground substance of the meniscus was present in every case. This degeneration is mainly mucoid, and other forms of degeneration are also present. Focal mucoid cysts occur at times in the avascular part, as previously noted. This tells us why meniscal cysts recur after the removal of the cysts alone. The degeneration which creates the cyst is still present and the meniscus must be removed to prevent recurrence. It should be pointed out that many authors have reported normal menisci in conjunction with meniscal cysts. This has not been our experience.

It has been noted by others that cysts do not occur with fracture or dislocation of the meniscus. This is not true, and a meniscal cyst may be associated with a meniscal fracture caused by typical trauma. This was noted in two cases in this series and has also been pointed out by Zäch-Christen.

The vessels about the cystic areas have attracted some attention. Many observers have noted normal vessels. Quite frequently, thickening of the small vessels with hyalinization, with occasional intimal thickening and thickening of the middle coat, have been reported. Phemister believed these vessel changes secondary and not the cause of the cystic change. In all our meniscal cysts, we note the typical vessel changes described previously both in the menisci of the cadaver and in those surgically removed. One may occasionally see a small lymphocytic infiltration about the vessels; plasma cells are rarely present. Hemorrhage is seen at times in or near the cysts.

A synovial inclusion was once seen in the outermost part of the vascular zone. This undoubtedly does not represent a cyst, but merely the adhesion of several villi. A peculiar whorl-like arrangement of meniscal fibers in the region of cysts was observed once, so that in that area complete cysts could not be formed.

It is interesting to speculate why meniscal cysts are present in greatest degree in one particular age group and why the external meniscus is more often involved. The age group in which cysts occur does not show any greater predilection for mucoid degeneration than other age groups, nor does it exceed other age groups in this. The comparative rarity of meniscal cysts is explained by the fact that only a small percentage of menisci undergoing mucoid degeneration undergo focal cystic change. It may be that the age group of twenty-five to thirty years is the first to show changes and that, if cysts are to be formed, they will be formed in this age group first. It may be objected that cysts should occur at a later age and in fact they do, even being reported at fifty-five years of age.

Its greater localization in the external meniscus is evidently due to a dynamic and an anatomical factor, since it is known that internal and

external menisci degenerate to an equal degree. Physiological knock-knee has been assumed as a factor. Fisher has noted that at the outer mid-part of the external meniscus there is a covering of synovia which separates the tendon of the popliteus from the meniscus, and that it is at this point that meniscal cyst develops. The external lateral ligament is not as intimately connected with the external meniscus as is the internal lateral ligament with the internal meniscus. It may be thus that the factor of growth spread of the cyst may account for its greater frequency in the external meniscus. This would infer that focal cystic formation occurred equally in both menisci and that the cyst could not spread in the internal meniscus. Whether or not this is true is uncertain.

Sex involves only the differential factor of trauma which we believe important in the genesis of the cyst, but not of the degeneration of the meniscus itself. Thus, a greater frequency is noted in men and our series comprised only men. If the factor of physiological knock-knee is important, it should be the more so in women.

A NOTE ON TUMORS (PSEUDOTUMORS) OF THE MENISCUS

Tumors of the menisci are rare, much rarer than cysts, and may occur in conjunction with meniscal cysts. Von Brunn first reported a fibroma of the meniscus in 1907. Zäch-Christen reported a giant-celled, xanthomatous tumor on the surface of a meniscal cyst. Tobler also reported a xanthoma arising from the internal meniscus. Kott has recently described a fibrous tumor of the meniscus, in structure very similar to that of the meniscus. These tumors may undergo cystic degeneration as noted in the case reported by Serafini, and in the case mentioned by us. Both the internal and external menisci are equally involved and the menisci appears grossly normal. Microscopic examination of the meniscus removed in Zäch-Christen's case showed a normal meniscus. Both sexes are equally affected. The age group in which meniscal tumors appear is in general like that of meniscal cysts. The symptomatology of tumor of the meniscus is essentially like that of cysts. Tumor of the meniscus is not to be confused with meniscal cyst, parameniscal cyst, palpable bursa about the knee joint, and free joint body.

The origin of these tumors is as yet not clear. The so called fibroma with a structure like that of the meniscus suggests an origin from the meniscal substance itself. It is unlikely that a detached piece of the meniscus would grow so as to form a large and definite body connected with it. A case reported by Entscho Dimoff as a rupture of the internal meniscus in a man of thirty-one, occasioned by typical trauma, revealed at operation a flattened, oblong structure, arising from the meniscal surface at its middle, and swinging forward and downward medially to overlap the inner edge of the meniscus. The lamellar flap was easily removed and the meniscus left intact. The author attributed this peculiar appearance to a tear of the superficial lamellae of the meniscus. The inward displacement of the flap caused typical locking. A case such as this resembles very

strongly those cases diagnosed as fibroma of the meniscus and suggests the traumatic origin of this so called tumor. If this manner of origin is true, then these are merely pseudotumors and not true tumors. The normal appearance of the meniscus in these cases may be accounted for by the regeneration of the surface tear occasioning this tumor.

The xanthomatous tumors are apparently associated with a high blood cholesterin, as in the case of Zäch-Christen, in which the blood cholesterin, taken a year after the resection of the cyst and tumor, was 200 milligrams per 100 cubic centimeters of blood. We know nothing of the deposition of cholesterin crystals in the menisci of the knee joint. That menisci may participate in disorders of metabolism, such as gout, was pointed out by Ishido. Yet the changes, in so far as described by him, are not specific as previously noted. Xanthomata are usually not considered as true tumors. Since no other types of tumor of the meniscus have been described, and since malignant tumors of the meniscus do not occur, it is perhaps preferable to consider these as pseudotumors, rather than true tumors.*

Recurrence has not been noted after removal of the tumor.

In the case of a man of thirty-seven, a mass, one by three by four centimeters, covered by a thin fibrous capsule, was attached by a tendinous pedicle to the middle of the outer margin of the internal meniscus.

Examination of the mass showed marked degeneration of the ground substance which very closely resembled the ground substance of the meniscus. Mucoid degeneration was marked and small focal cysts were present in many areas. The walls of these cysts were degenerated ground substance. There was marked hemorrhage throughout the substance of the tumor. A thickened but torn synovial lining was present, on which some lymphocytes and red cells were present. The meniscus itself was apparently not sectioned. A diagnosis of a necrotic, pedunculated fibroma, attached to the meniscus, was made. The marked degeneration and necrosis within the tumor were due undoubtedly to the temporary interposition of the tumor between the joint surfaces. The pedicle was relatively avascular. The blood vessels in the tumor showed changes of the type previously described.

Two other meniscal tumors have been examined in the laboratory. One was a triangular, pedunculated mass, freely movable, and attached to the outer and anterior surface of the internal meniscus. This was a xanthoma undergoing necrosis, microscopically. The meniscus itself was not removed. The other specimen consisted of a meniscus to which was affixed a small, roughly oval, pedunculated body, one centimeter long and eight-tenths of a centimeter wide. Microscopically, the mass consisted of hyalinized tissue and granulation tissue, in which clusters of thin-walled, blood-filled sinuses were seen in areas. There was extensive necrosis within the tumor. A diagnosis of a pedunculated granuloma, possibly on the basis of a hemangioma, was made.

* Pieri has described a sarcoma of the internal meniscus, which occupied the anterior end of the meniscus and was the size of a small nut. The meniscus was removed. The follow-up period was only four months and, at that time, the patient, a man, thirty-one years old, was free from symptoms. A pathological diagnosis of fusocellular sarcoma of the meniscus was made and the tumor was considered malignant.

THE CLINICAL CORRELATION

The type of trauma which causes fracture or dislocation of the meniscus becomes less with advancing age. This is generally true but not specifically so. Sports injuries play a greater part in the earlier decades, whereas accidents of major or minor degree predominate in the later decades. Thus, in the second decade, the lesion was attributed to sports in ten and to accident in six; in the third decade, to sports in thirteen and to accident in sixteen; in the fourth decade, to sports in three and to accident in thirteen; in the fifth decade, to sports in one and to accident in six. After the fifth decade, sports injuries naturally play no part.

Since a definite history of trauma is present in about seventy-six cases, and since degeneration of the meniscus appears in practically all of the menisci examined, it might be argued that the trauma causes the degeneration. This, of course, is fallacious. These findings contradict Mandl's statement that intact menisci show no change, whereas surgically removed menisci do.

Given the process of degeneration as a finding of progressive age, we may reason thus: The degenerated meniscus need not fracture and this is true in the vast majority of people. Again, the meniscus may fracture, not from any process of degeneration, but from the usual traumata which produce fracture and dislocation of the meniscus. Finally, the degeneration of the meniscus may be the direct cause of fracture,—in other words, a *pathological fracture* of the meniscus.*

Läwen noted that spontaneous fracture of the meniscus occurred, either crosswise or lengthwise, in association with arthritis deformans. Ishido believed that not all meniscal fractures were traumatic in origin.

The first two possibilities have already been proven, both by our work and by the work of other authors. In order to prove the validity of the third proposition, we must examine cases with histories of no or atypical trauma, and cases associated with arthritis. It is to be expected that those menisci which show pathological fracture will be greatly degenerated menisci in the later age groups, with or without other joint complications. It is also expected that the trauma, either singly or serially applied, which causes the pathological fracture, will be small. Pathological fracture of the meniscus must occur uncommonly and does not obtrude itself in our minds, since we are not accustomed to think of such a pathological fracture of the meniscus.

CASES WITHOUT A HISTORY OF TRAUMA

Eight cases are represented in this group without trauma and these may be divided into two groups. Five cases,—one in the second decade,

* Reference should be made to the excellent paper of Andreesen which came to our attention a short time before the proofs of this paper were read. His study was confined only to operatively removed menisci. His findings and his interpretations are in general in agreement with ours. He too enunciates the concept of pathological fracture of the meniscus, though he localizes the site of fracture only at the junction of the outer vascular and inner avascular layers, the resultant longitudinal fracture corresponding, according to him, to the bipartite meniscal tear of Steinmann.

one in the third decade, two in the fourth decade, and one in the fifth decade—noted that their illness was of long duration,—from four to ten years. The fifth case had a healed pyarthrosis of the knee twenty-eight years before admission, though the duration of meniscal symptoms was not noted in the history. The remaining three cases comprised one in the fifth decade, and two in the sixth decade; in these three the duration of symptoms was short,—from four weeks to one year.

Of the two women, the one in the second and the one in the third decade, it is noted that they were children, aged twelve and fourteen respectively, when their symptoms began. An initial trauma of an unstriking degree, such as twisting the knee in playing or climbing, might well have been forgotten. In one, the cartilage was loose; in the other, it was torn. Degenerative changes were of mild to moderate degree, with mild vessel changes. The two in the fourth decade, a man and a woman, dated their symptoms five and ten years back respectively. Again, a moderate trauma might well have been forgotten. Degeneration of the meniscus in both cases was moderate. There is nothing in these four cases which suggests pathological fracture of the meniscus.

The fifth case was more complicated, in that pyarthrosis of the knee had been present twenty-eight years before and osteo-arthritis with joint mice was now present. Degenerative changes in the meniscus were marked. This might possibly be due to a pathological loosening of the meniscus, most probably dependent on the present arthritis rather than the past pyarthrosis. The meniscus was not fractured. We are none too familiar with the effects of suppuration on the menisci, though the experimental studies of Ohta indicated destruction of the menisci depending on the type of organism introduced into the knee joint. In order of frequency, the organisms having the greatest meniscolytic effects are staphylococci, streptococci, pneumococci, and, finally, bacillus coli. If the endotoxins of these bacteria are strong, the meniscus may be completely destroyed or converted into granulation tissue; if weak, there occurs some necrosis with cell nests of regeneration. The meniscal cartilage is attacked before joint cartilage.

The other three cases showed an association with arthritis. In a man, forty-three years old, with a symptom history of one year, the meniscus was loose at its anterior end. We cannot say definitely if this meniscus was pathologically loosened, though, microscopically, degenerative changes of moderate to marked degree were present. The same holds true of a woman, fifty-seven years old, who suddenly felt a snap in the knee four weeks before admission. No trauma was noted and the joint showed slight arthritic changes. Degeneration of the meniscus was of moderate degree. The last case, a colored man of fifty-seven, with a definite arthritis and snapping of the knee for ten months, showed no locking and some pain on the inner aspect of the knee joint. Broadening and fraying of the posterior part of the meniscus, with irregular transverse fracture revealed by both arthroscopy and arthrotomy, confirmed our

idea that this was a pathological fracture of the meniscus. Moderate to marked vascular and degenerative changes of the meniscus were present.

CASES WITH ASSOCIATED ARTHRITIS

Whether a primary arthritis creates secondary degenerative changes in the meniscus or whether degenerative changes in the meniscus may lead to arthritis is uncertain. Many English surgeons believe that an injured meniscus may provoke an arthritis, according to Hoffmann. The effects of meniscectomy on subsequent arthritis will not be discussed here.

Twelve cases of arthritis, preceding or coexisting with the meniscal lesion, are recorded in this series. Five occurred in the fifth decade, of which two have been detailed, four in the third decade, of which one has been detailed, and three in the sixth decade. None of the four cases in the third decade can be considered as showing pathological fracture of the meniscus. The arthritic process was of mild degree and located in the adjacent condyle. Two cases in the fifth decade showed probable pathological fracture of the meniscus. One case has already been detailed. The other occurred in a man in whom a synovectomy was done and in whom this old unnoticed fracture of the meniscus was seen. In a man of forty-four, in whom a synovectomy was also done, it was seen that the meniscus was thinned and frayed, though it was not fractured. In the sixth decade, two cases of pathological fracture or loosening of the meniscus were noted. One case has already been detailed. The other occurred in a woman in whom an arthritis of the knee was present for ten years. The meniscus was loose and frayed and showed marked degenerative changes.

A marked degeneration of the ground substance, with a preponderance of mucoid degeneration, was noted in those menisci considered pathologically fractured or loosened.

Joint mice were coincidently present in one case in the third decade, in three cases in the fifth decade, and in one case in the sixth decade, in association with arthritis. Two cases in this series showed Pellegrini-Stieda's disease,—that is, a paracondylar ossification—and in one, the bony mass was removed. Tears and fraying of the crucial ligaments, injury to the infrapatellar fat pads, hypertrophic synovitis, tearing of the ligamentum mucosum, adhesions, etc., may accompany meniscal disease.

CONCLUSIONS

Degeneration of the menisci of the knee joint occurs as a typical change of progressive age. The severity of degeneration does not always parallel age. This degeneration is noted equally in both menisci, and in menisci which have been surgically removed, as well as in menisci which have remained intact in the knee. The term "meniscosis" is suggested to describe the degenerative changes which the meniscus undergoes. The exact relation between degeneration of the meniscus and the alteration of the blood vessels described is quantitatively uncertain. The menisci tend

to regress under several factors which include daily small traumata of subclinical import, poor vascularity quite independent of vessel pathology, the presence of intra-articular disease, vessel alterations which are so frequently present, and probable alterations in synovial nutrition. Hempel has indicated that cartilage may be destroyed by ferments in the synovial fluid. If this is true, this may hold true too for the menisci, which receive some nutrition from the synovial fluid.

Meniscitis does not exist as an entity. Meniscosis need not express itself clinically; though rarely, in the later decades of life, it may be the cause of pathological fracture of the meniscus, in a patient without a history of trauma or in association with arthritis. Meniscal cysts are degenerative in origin.

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EXTRA-ARTICULAR ARTHRODESIS OF THE SHOULDER *

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Tuberculosis of the shoulder joint is characterized by the particularly chronic course of the disease, and by the tendency to slowly progressive destruction of the head of the humerus and of the glenoid. So extensive is the bone destruction that the upper end of the humerus gradually sinks inward, leaving a very marked hollow below the prominent acromion process, which accounts for the "pseudo-dislocation" described by older writers. Despite the extensive bone destruction there is relatively little caseation, and the rarity of abscess or sinus formation has led to the nomenclature of "caries sicca". Since sinuses are uncommon, there is seldom secondary pyogenic infection, and bony ankylosis is rarely secured.

In the past, it has been accepted that the duration of the disease in the shoulder joint is from three to five years. It is well recognized that the functional result is only satisfactory if the humerus is ankylosed to the scapula at an angle of seventy or eighty degrees' abduction, thirty degrees' external rotation, and thirty degrees' forward flexion. The limb must be held in this position not only until the disease is quiescent but until the fibrous ankylosis is sufficiently firm to maintain the position. There can be little doubt that it is the second factor which has been of greater importance in determining the unusually prolonged recovery period. Quiescence should be secured by immobilization and general treatment just as quickly in the shoulder as in the elbow, knee, or any other joint. But, if the limb is released from the abducted position when the disease is quiescent in twelve or eighteen months, the fibrous union will gradually stretch, owing to the weight of the limb, the effect of gravity, and the position of rest of the limb by the side of the trunk. Gradually the angle between the humerus and the scapula is reduced, the range of abduction secured by scapular movement becomes less, and ultimately ankylosis is consolidated in a position which is no better than it would have been had the limb never been abducted. For these reasons, patients have had to resign themselves to the discomfort and inconvenience of an abduction frame or plaster spica for no less a period than three, four, or five years, because only after that interval is the ankylosis sufficiently consolidated to retain adequate shoulder movement.

Extra-articular arthrodesis has been practised in the spine for many years, and more recently has been advocated by Hibbs in the hip joint. Although Hibbs himself believed that extra-articular arthrodesis was a measure of value in the treatment of tuberculous disease at all stages, this broad view has not been generally accepted. In England the usual practice still is to adopt conservative measures until the disease is quiescent;

* Received for publication, December 27, 1932.

but more and more widely it is being recognized that an extra-articular arthrodesis is often advisable in the terminal stages of treatment, in order to consolidate ankylosis and to prevent recurring deformity. This is the routine which is now very generally adopted in the treatment of tuberculous disease of the hip.

How much more definite is the indication for extra-articular arthrodesis of the shoulder joint as a terminal phase of treatment? The tendency to deformity is much more marked in the shoulder than in the hip because the constant action of gravity must be contended with. Moreover, it is always possible to fit a plaster or leather spica to the hip joint, which will control deformity without preventing the patient from resuming his occupation. In the shoulder, on the other hand, deformity can only be controlled by continuing the complete treatment of fixation in abduction, a measure which absolutely prohibits the resumption of active work.

Not only is the indication for operation particularly strong, but the anatomical features of a shoulder which has been disorganized by tuberculous disease are peculiarly favorable to extra-articular arthrodesis. Intra-articular arthrodesis is notably unreliable even in the healthy shoulder joint, and it is still more difficult to secure bony union by Steindler's intra-articular arthrodesis of the tuberculous shoulder. But, where the glenoid and the greater part of the humeral head have been destroyed, the inward displacement of the upper end of the humerus leaves the acromion process projecting well beyond it. It is now a perfectly easy procedure to angulate the acromion downward, and implant it in the upper shaft of the humerus in the region of the greater tuberosity. In this way, firm bony ankylosis is secured between the humerus and the scapula without actually encroaching on the diseased area. The cosmetic appearance is very materially improved, because there is no longer a hollow where the head of the humerus should be, with the very ugly projecting spur of the acromion process above it. The normal rotund outline of the shoulder is restored.

TECHNIQUE OF NEW OPERATION

A straight incision is made over the point of the shoulder, centering on the tip of the acromion process (Fig. 1). It extends upward for about three inches midway between the clavicle and the spine of the scapula, and extends downward for a similar distance toward the deltoid insertion. The flaps are dissected up sufficiently to expose the whole of the outer surface of the upper three inches of the humerus, the outer third of the clavicle, the acromioclavicular joint, and the outer third of the spine of the scapula (Fig. 2-A).

The deltoid is separated subperiosteally from the clavicle, acromion, and scapula, and the fibromuscular flap is turned downward. Both upper and lower surfaces of the acromion process are freshened and made raw by removing the cortical layer of bone.

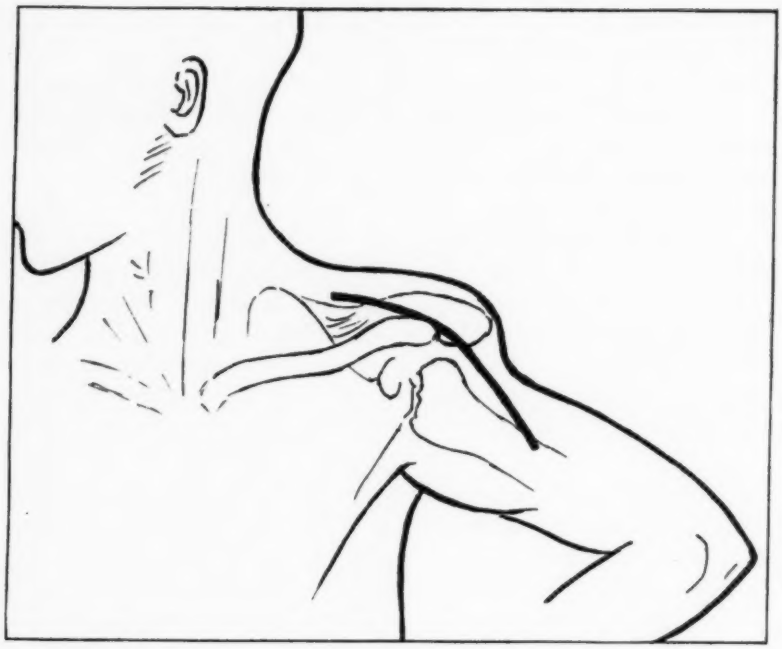

FIG. 1
Line of incision.

A broad flap of bone, one inch wide and two inches long, is raised from the outer surface of the upper end of the humerus by driving an osteotome vertically into the upper part of the greater tuberosity immediately beyond the capsular attachment, the osteotome being held in the long axis of the humerus (Fig. 2-B). The flap of bone is gently levered outward, but is not completely fractured at its base, so that when the osteotome is removed the flap tends to spring back into position.

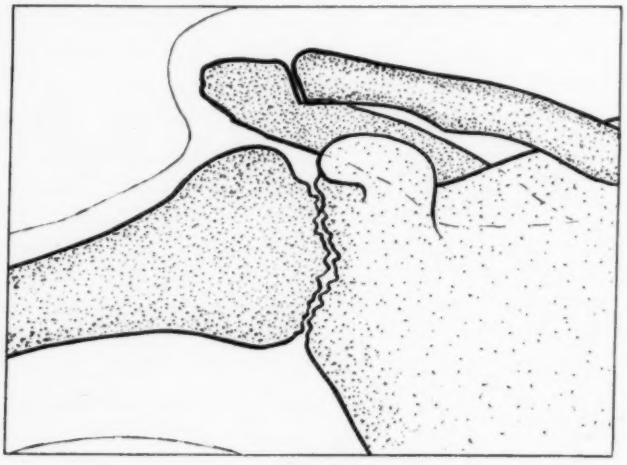

FIG. 2-A

The clavicle is partly fractured a few inches from its outer end, and the spine of the scapula is partly fractured at a similar level. The arm must now be held in the abducted position, and the whole acromioclavicular mass is angulated downward, hinging at

the point where the bones were half fractured. It is wedged underneath the flap of bone raised from the humerus, so that its raw, freshened surfaces are impacted into the cancellous bone of the upper shaft of the humerus (Fig. 2-C).

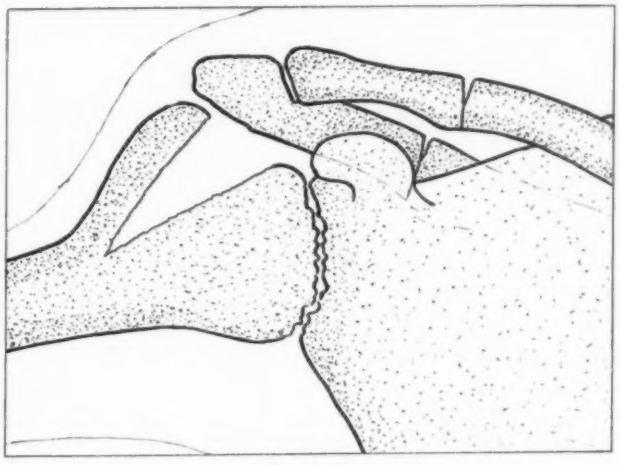

FIG. 2-B

Fixation may be augmented by a few strong sutures, and if necessary bone chips or osteoperiosteal grafts from the tibia may be implanted. The wound is closed in layers and the limb put up in a plaster spica, in a position of eighty degrees' abduction, thirty degrees' forward flexion, and thirty degrees' external rotation.

POSTOPERATIVE TREATMENT

In a fortnight, when the stitches have been removed, the wound is healed, and the postoperative swelling has subsided, a very closely fitting plaster spica is applied over a single layer of thin stockinet. The position is confirmed roentgenographically, and, if it is satisfactory, the plaster remains undisturbed for four months. If further roentgenograms show bony fusion, the plaster is removed and an abduction frame applied. The patient practises abduction movements and, when the scapular muscles are sufficiently developed to enable him to hold the limb against gravity in right-angled abduction, the frame is gradually discarded. At first it is left off for an hour a day, but the period of freedom is rapidly increased so long as the power of active abduction is retained.

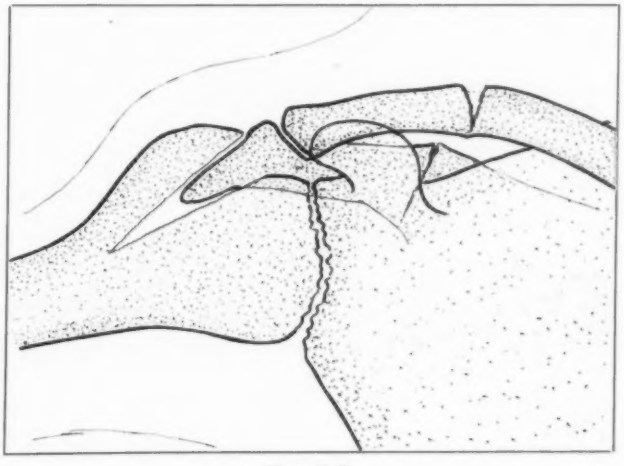

FIG. 2-C

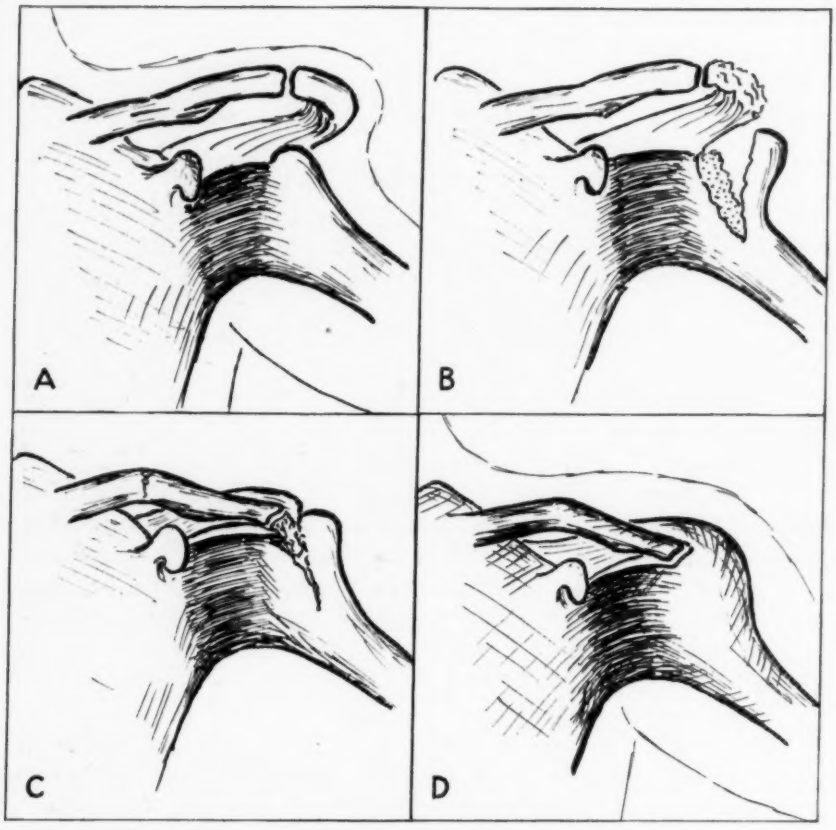

FIG. 3

Stages of the arthrodesis, showing the relation of the graft to the capsule.

A. Before operation. Owing to bone destruction, the head of the humerus has sunk inward leaving the acromion abnormally prominent.

B. The acromion has been freshened and the flap of bone raised from the humerus.

C. The clavicle and spine of the scapula have been fractured and the acromion is impacted into the cancellous bone of the upper end of the humerus.

D. The end result after extra-articular fusion.

The operation has been performed in three cases of tuberculosis of the shoulder, and in each case a sufficient interval of time has elapsed to judge the result.

CASE REPORTS

CASE 1. P. B., male, aged seventeen years:

July 1929. Seven months' history of weakness of shoulder. Progressive difficulty in abduction. Clinically and roentgenographically typical of caries sicca. Conservative treatment by frame immobilization for eighteen months. Roentgenograms then showed recalcification of glenoid and head of humerus (recalcification = diminution of hyperaemia = quiescence). Extensive destruction but no ankylosis (Fig. 4-A).

January 1931. Extra-articular arthrodesis. Wound healed by first intention. Plaster spica for four months. Frame gradually discarded during next month.

June 1931. Roentgenogram showed firm bony ankylosis (Fig. 4-B).

FIG. 4-A

Case 1. Roentgenogram of shoulder after eighteen months' frame immobilization.

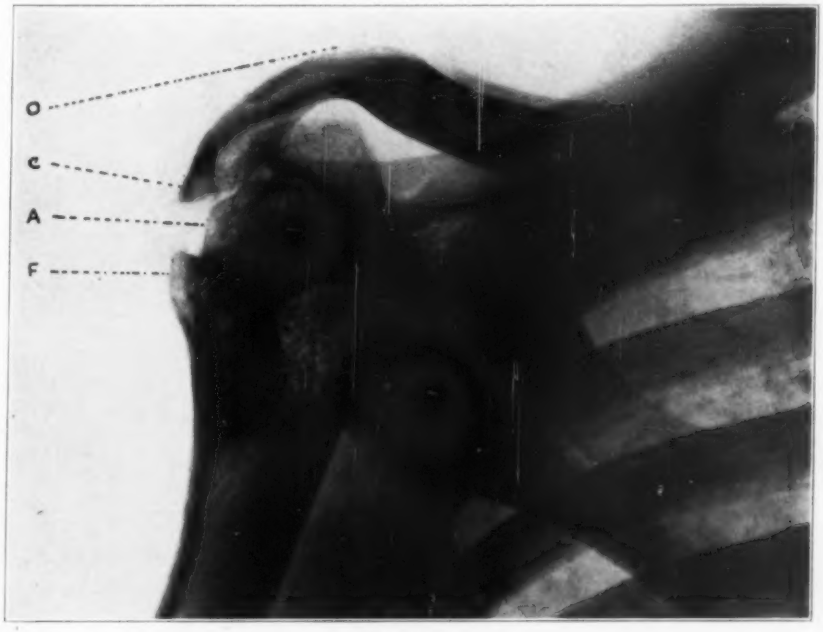

FIG. 4-B

Case 1. After extra-articular arthrodesis. *C* = clavicle, articulating with *A*, the acromion, which is firmly fused with the humerus. *F* = outer margin of the flap of bone raised from the humerus. *O* = level of osteotomy of clavicle.

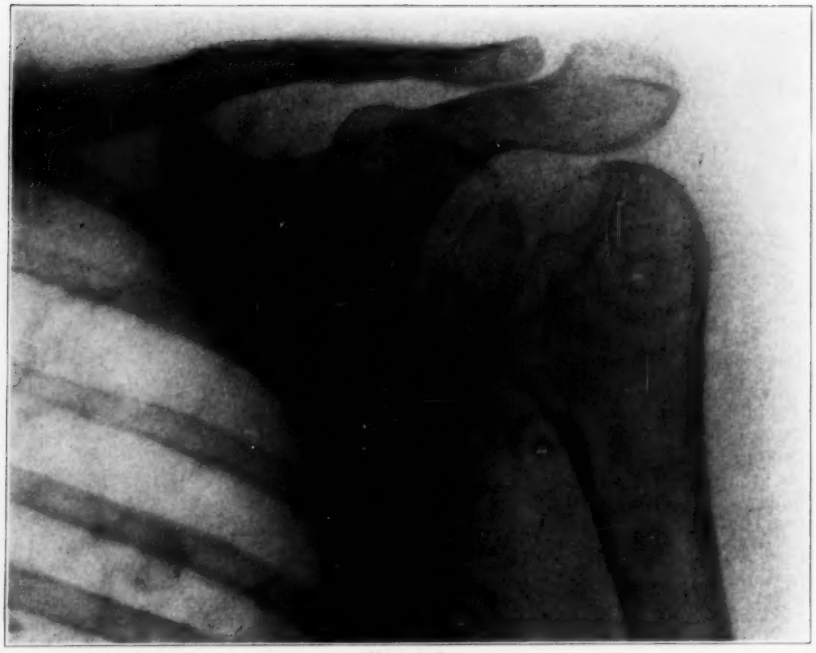

FIG. 5-A

Case 2. Roentgenogram of shoulder at commencement of treatment.

FIG. 5-B

Case 2. Roentgenogram after six months' conservative treatment by frame immobilization.

November 1932. No recurrence of symptoms, and no recurrence of disease elsewhere. Can abduct limb through 110 degrees and can reach face and head easily. Cosmetic result fairly good.

FIG. 5-C

Case 2. Six months after extra-articular arthrodesis.

FIG. 5-D

Case 2. Photograph showing end result.

FIG. 6-A

Case 3. Roentgenogram at commencement of treatment (tuberculosis confirmed microscopically).

FIG. 6-B

Case 3. Roentgenogram six months after excision of joint and combined intra-articular and extra-articular arthrodesis. (In this case the clavicle, as well as the acromion, has been freshened and impacted into the humerus.)

CASE 2. R. S., male, aged twenty-one years:

October 1930. Six months' history of pain and stiffness in right shoulder. Roentgenogram confirms clinical diagnosis of caries sicca (Fig. 5-A). Conservative treatment by immobilization in abduction frame for six months. Roentgenogram shows recalcification (Fig. 5-B).

April 1931. Extra-articular arthrodesis with reenforcement by osteoperiosteal grafts. Stitch abscess drained for few weeks. Plaster spica four months. Frame gradually discarded during next four months.

December 1931. Roentgenogram shows firm consolidation (Fig. 5-C).

July 1932. Excellent result. Cosmetic result very satisfactory (Fig. 5-D). Movements of shoulder girdle fifty per cent. of normal. Firm bony ankylosis. Disease cured. No recurrence of symptoms.

CASE 3. W. R., male, aged thirty-eight years:

January 1932. Three weeks' history of pain in the shoulder. Roentgenograms show extensive destruction of the head of the humerus. Tuberculous disease has been present in bone much longer than three weeks. More recent involvement of joint (Fig. 6-A). Conservative treatment in frame for three months. No further destruction.

April 1932. Combined intra-articular and extra-articular arthrodesis. Caseous masses evacuated from head of humerus. Owing to involvement of greater tuberosity, extra-articular fixation was more difficult than usual. The clavicle, as well as the acromion, was freshened and impacted into the humerus. Plaster spica applied for four months. Delayed healing of wound.

November 1932. Still wearing frame for part of day. Clinically, ankylosis is firm and painless. Roentgenographically, humerus and spine of scapula firmly united (Fig. 6-B). Joint becoming obliterated. No recurrence of symptoms. Movements of shoulder girdle forty per cent. of normal.

SUMMARY

Tuberculous disease of the shoulder joint recovers slowly by fibrous ankylosis which becomes sufficiently firm to maintain the abducted position only after several years' fixation. The disease occurs most commonly in the adult, and the average duration of conservative treatment is three to five years. Attempted acceleration of treatment reduces the scapulohumeral angle and abduction movement is lost.

For these reasons operative fusion of the joint is indicated as a terminal stage of treatment after quiescence has been secured by conservative measures. Roentgenographic evidence of quiescence, shown by recalcification of the bones, appears within about twelve months.

A new operation is described by which solid bony fusion can be secured without opening the joint, and the arthrodesis is definitely extra-articular. The cosmetic result is considerably improved by the operation.

Three cases are reported in which a sufficient interval of time has elapsed to judge the operation. In no case was there any aggravation of the disease or recurrence elsewhere, and in all three cases bony ankylosis resulted.

PRESPONDYLOLISTHESIS

Its Roentgenographic Appearance and Clinical Significance *

BY SAMUEL KLEINBERG, M.D., NEW YORK, N. Y.

From the Hospital for Joint Diseases

The orthopaedic surgeon is at present concerning himself with an intensive investigation of the causes of back disability. Certain congenital lesions of the spine are known to be important etiological factors in static and traumatic disturbances of the lumbosacral area. To this group may now be added prespondylolisthesis, a condition in which there is a congenital laminar defect of the last lumbar vertebra without displacement of any of its segments.

Somewhat over two years ago, the author operated on the lumbosacral area of a young man's spine to obtain a vertebral fusion in a very painful back, the roentgenogram of which appeared normal. He found the posterior arch of the last lumbar vertebra abnormally movable as a result of a bilateral defect in the neural ring at the pedicles. This stimulated him to a more critical study of the roentgenograms of cases of back disability. He soon discovered two patients with backache in whose roentgenograms he demonstrated a defect in the pedicles of the last lumbar vertebra, and confirmed this in the case of one of them who submitted to operation. The two patients who were operated upon were relieved of their backache and disability. The laminar defect noted in these three cases was similar in location and appearance to that seen in cases of actual dislocation of a lumbar vertebra, or spondylolisthesis. It seemed reasonable to assume that in these patients the author was dealing with a situation which in its essential pathology was a precursor to a slipping of the vertebral body, and hence appropriately called a prespondylolisthesis. He has since found six additional cases, in three of which he has had the opportunity of operating and actually seeing the area in which there was an osseous defect.

The clinical history of prespondylolisthesis has been very much the same in all of the cases. The patients, who thus far have all been adults, complain of a sense of weakness and pain in the lower part of the back. The pain may come on suddenly, as after some strain, or gradually in the course of more or less arduous work. Once the pain appears, it continues, with some remissions. It is aggravated by strenuous physical activity and is relieved by rest and support of the back. The pain is most pronounced at the lumbosacral area. In several of the patients there was an accompanying right sciatic neuralgia. In two cases there was increasing weakness in the lower limbs which interfered with locomotion.

* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.

The physical examination yields little that is definitive. Usually there is local tenderness to pressure at the lumbosacral junction. If the backache is marked there may be spasm of the erector spinae muscles with some limitation of the spinal motions. There may or may not be an exaggeration of the lumbar lordosis. There are no gross neurologic changes. The subjective symptoms and the objective findings indicate a lesion in the lower lumbar region, and the need for a roentgenographic study.

The roentgenograms reveal the pathology. In the anteroposterior view the vertebrae appear normal.* In the lateral view, however, one sees a vertical or slightly oblique defect in the pedicles between the articular processes of the last lumbar vertebra, separating the body and superior articular process in front from the inferior articular process and the neural arch posteriorly, exactly as one finds it in a spondylolisthesis. The alignment of the lumbar vertebrae and the sacrum is entirely undisturbed. The osseous defect varies in width from approximately a sixteenth of an inch to an eighth of an inch. The outlines of the adjacent bony surfaces are irregular. There is no sign of any new bone deposit. The defect is sometimes seen more clearly in an oblique view. In a little over half the cases there is an exaggeration of the lumbosacral angle, with the sacrum sometimes almost horizontal and the lumbosacral plane nearly vertical.

The findings at operation are dramatically convincing. As soon as one cuts through the lumbar fascia it becomes at once apparent that the posterior arch of the affected vertebra (in all of the cases here reported it has been the last lumbar vertebra) is abnormally movable and loose. If one grasps the spinous process of the third or fourth lumbar vertebra with a strong clamp, one can obtain some slight movement of the vertebra. When one takes a similar hold of the spinous process of the last lumbar vertebra, he can move it and the laminae vertically and laterally a distance of perhaps half an inch, obtaining an uncomfortable sense of looseness in the attachment of these structures. When the laminae and pedicles are exposed by subperiosteal dissection, a defect is found in the pedicles. In none of the author's cases was there any callus to suggest a fracture. This is entirely in accord with Willis's findings in his studies of cadavera with spondylolisthesis.

A study of five hundred roentgenograms of the lumbosacral area discloses two instances of prespondylolisthesis and two of spondylolisthesis. This average is much below Willis's figures for congenital osseous defects in the neural arch of the lower lumbar vertebrae. But the films examined were made five or six years ago when the technique of roentgenography was not quite so accurate as at present. The author believes that a more recent group would give a greater incidence of vertebral

* One of the author's cases is perhaps an exception to this. In this instance there was visible a horizontal linear defect in the neural arch below each articulation between the fourth and fifth lumbar vertebrae. This may be merely a chance finding.

laminar defects. What is more important, however, is the fact that the histories of the cases of prespondylolisthesis showed that all but one of the patients had symptoms referable to the back. The patient who was the one exception had pains along both lower limbs, which led a somewhat inexperienced examiner to be surprised because the individual did not have enough of a flat foot to account for the pain, overlooking the fact that pains in the lower limbs may be an expression of a spinal lesion.

The author has collected nine cases of prespondylolisthesis. The details of their histories, the findings in the physical examination, in the roentgenograms, and at operation are recorded in the case reports which follow. All the patients were adults, most of them past middle age. Presumably the condition continues asymptomatic until some circumstance—a single marked injury or a succession of minor strains—stretches and loosens the connective tissue bridging the defect, following which backache and disability ensue. It may be assumed, too, that in some patients the osseous lesion is unilateral so that symptoms of strain never appear, or else are so mild as to be overlooked. There must be many instances without symptoms which do not reach the surgeon.

The recognition of the existence of a state of prespondylolisthesis has a twofold importance. First, prespondylolisthesis itself is a competent cause of backache and back disability, and it can, by appropriate treatment, be satisfactorily controlled. Secondly, prespondylolisthesis manifestly precedes actual subluxation of a vertebral body, or spondylolisthesis, as no case of spondylolisthesis has been discovered in the newly born. Consequently, it seems reasonable to conclude that, if a laminar defect is detected, the occurrence of a spondylolisthesis can be prevented by a spine fusion.

CASE REPORTS

CASE 1.* J. W., aged thirty-three years, fell two and a half years ago, striking his back against a post. Since then he has had disabling backache. The examination, clinical and roentgenographic, was negative. At operation, which was performed because conservative treatment had not given any relief, the author found a separate neural arch due to a bilateral defect at the pedicles. The operation, a spine fusion, resulted in a cure.

CASE 2.* O. L., aged forty-one years, a carpenter, consulted the author at his clinic about one year ago for increasing and disabling backache. The patient was well up to four months previously when, without any apparent cause, he experienced pain in the lower part of his back. This pain became gradually worse, so that walking was very difficult. The examination revealed an increase in the lumbar hollow, inconstant tenderness at the lumbosacral junction and slight limitation of the spinal motions. The lateral roentgenogram showed an almost horizontal sacrum and a laminar defect, almost an eighth of an inch wide, in the fifth lumbar vertebra. The alignment of the lumbar vertebrae and the sacrum was normal. A spine fusion was performed. At operation there were found a loose posterior arch and a bilateral laminar defect in the fifth lumbar vertebra. This man has been completely relieved.

* These three cases were included in a communication on "Spondylolisthesis and Prespondylolisthesis" sent some time ago to *Archives of Surgery* and shortly to be published therein.

CASE 3.* H. G., aged sixty-four years, came to the author's clinic because of pain of four weeks' duration in the back and the right thigh. The physical examination was negative, but the lateral roentgenogram showed a wide laminar defect.

CASE 4. N. P., aged forty-one years, fell while at work, striking his back. He had immediate backache, which increased until he could not get about. He was seen several months after his injury, at which time he complained of pain in his back and the back of the right lower limb, approximately in the course of the sciatic nerve. The pain was increased by all movements of his body, so that he was practically totally incapacitated. The patient was a particularly well built man who had difficulty in walking and even in standing. His body was tilted to the left. His lumbar spine was flat. There was marked tenderness at the lumbosacral junction and limitation of the spinal

FIG. 1

Case 4. Anteroposterior view, showing horizontal defect below each superior articular process.

* See foot-note, page 874.

motions. There were no neurological changes. The anteroposterior roentgenogram (Fig. 1) showed a peculiar, almost horizontal defect through each lamina directly below the superior articular process. The lateral view showed vaguely a laminar defect.

A diagnosis of prespondylolisthesis was made and a spine fusion advised. It was felt that the lesion was undoubtedly congenital, but the injury had stretched the connective tissue at the laminar defect, resulting in abnormal laxity of the posterior arch of the fifth lumbar vertebra and causing disabling backache. At operation, the author found that the posterior arch of the fifth lumbar vertebra was very freely movable by reason of a bilateral defect in the pedicles between the articular processes. Apparently movement of the posterior arch during the operation increased the gap of the laminar defect, because a subsequent lateral roentgenogram (Fig. 2) shows the osseous lesion more clearly than the original picture. This patient is still under observation at the hospital.

Case 5. N. D., aged fifty-five years, was admitted to the author's service for pain in his back, especially the coccyx. He was well until two years ago, when without any known cause, he experienced severe pain in the upper part of his back, radiating to the sides. The backache diminished in degree, but persisted. Five months before admission he began to have severe pain in the lumbar area. Two weeks before entering the hospital his coccyx became so painful that he sought medical aid.

Examination showed a thin, worn-out looking individual who had marked round shoulders and a hollow back. His lumbar spine was freely movable. His coccyx was abnormally movable and tender. Neurological investigation was negative. The roentgenograms showed a dorsal spondylitis. Also, in the lateral view of the lumbosacral area, a defect in the posterior arch of the last lumbar vertebra was visible (Fig. 3). The alignment of the lumbar vertebrae and the sacrum was normal. There was a slight increase in the lumbosacral angle. The laminar defect is very clearly seen in the original film, but not in the copy here reproduced.

A spine-fusion operation was performed. The posterior arch was found to be loose and abnormally movable, exhibiting a bilateral laminar defect through the pedicles between the articular processes.

Case 6. F. McD., aged twenty-nine years, injured her spine in an automobile accident in October 1930. A diagnosis of fracture of the spine was made and a plaster-of-Paris jacket was applied. This was discarded in about six months as she felt well except for occasional pain in the back, radiating down the right lower limb. For several years this patient has had unexplained periodic attacks of vomiting and pain in the right upper quadrant of the abdomen. The patient was admitted to the medical service of the hospital in December 1932. Very thorough examination, including a gastro-intestinal roentgenographic series, revealed no abdominal lesion, and she was transferred to the author's service.

Examination on January 21, 1933, showed a somewhat overweight person with a marked round, hollow back. The spinal motions were unrestricted. There was tenderness along the lumbar spine, especially at the lumbosacral junction. There were no neurological disturbances. The roentgenogram showed in the lateral view (Fig. 4) an ancient healed compression fracture of the body of the twelfth dorsal vertebra, and a marked laminar defect in the fifth lumbar vertebra with normal alignment of the lumbar vertebrae and the sacrum,—that is, a prespondylolisthesis.

A spine fusion for stabilization of the lumbosacral area was advised and performed. The operation revealed a markedly loose posterior arch of the fifth lumbar vertebra with a bilateral laminar defect, as shown in the accompanying drawing (Fig. 5) made for the author by his resident, Dr. Lieberman. The extreme laxity of the posterior neural arch in this and the other cases justified Dr. Willis's term of "separate neural arch".

Case 7. Mrs. J. S., aged forty-three years, consulted the author for pain in the lower back. This radiated down the back of the right thigh and leg to the dorsum of

FIG. 2

Case 4. Lateral view. Note wide laminar defect at *a*. In this instance the graft was extended from the second lumbar vertebra to the middle of the sacrum to assure thorough immobilization.

FIG. 3

Case 5. Lateral view; *a* points to laminar defect in fifth lumbar vertebra.

FIG. 4

Case 6. Lateral view, showing wide defect or gap in neural arch of fifth lumbar vertebra. This was confirmed at operation.

her foot. The backache, which began about six months previously without any apparent cause, is more or less continuous; it is aggravated by exercise and relieved by rest.

The patient is short, stocky, and overweight. Her back is symmetrical but with some increase in the lumbar hollow. There is definite restriction of all movements of the lower lumbar spine, with tenderness to pressure in this region. Pressure over the lumbosacral area causes pain along the right sciatic nerve. The roentgenograms show a laminar defect of the fifth lumbar vertebra, establishing the diagnosis of prespondylolisthesis.

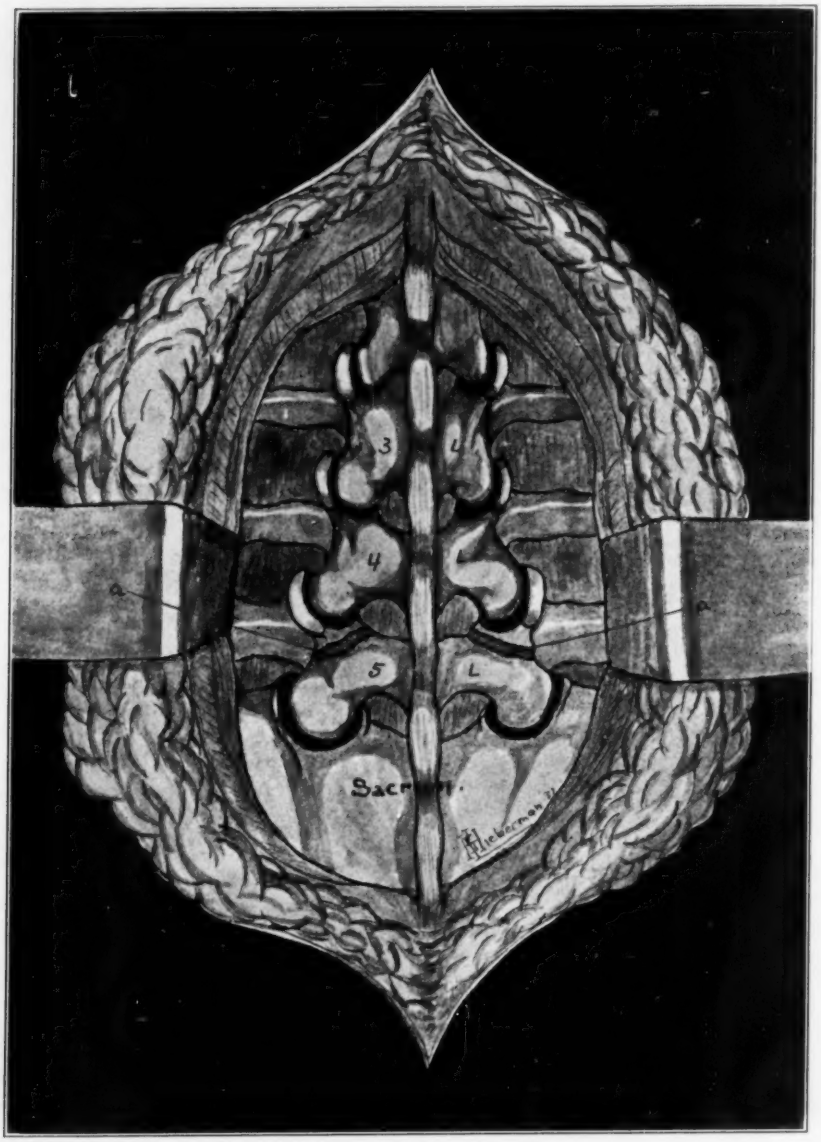

FIG. 5

Case 6. Diagrammatic sketch of operative findings: *a* indicates defect on both sides of neural arch of fifth lumbar vertebra; the broad black lines indicate intervertebral articulations.

CASE 8. J. P., aged thirty-three years, came to the out-patient department in May 1927, complaining of pain in the lower back and in both legs. The pain had persisted for five years, but finally had become so severe that the patient had difficulty in walking. There was marked stiffness of the lumbar spine and tenderness at the lumbosacral junction. The clinical diagnosis was lumbar arthritis with secondary sciatica. The roentgenographic evidence was not appreciated at that time. The lateral view (Fig. 6) shows clearly a large, ragged defect, nearly a quarter of an inch wide, in the pedicles of the fifth lumbar vertebra. In this case the posterior arch of the fifth lumbar vertebra was so loose that it manifestly could cause the train of severe symptoms of which the patient complained.

FIG. 6

Case 8. Lateral view. Note unusually wide and ragged defect in pedicles of fifth lumbar vertebra.

CASE 9. T. T., aged thirty-four years, came to the dispensary in May 1927. For ten months he had complained of pain in the back. He gave no history of injury, and the clinical examination was negative. The present examination of the lateral roentgenogram shows a wide laminar defect in the fifth lumbar vertebra. Unfortunately, the film had a finger streak across the sacrum, obscuring its outline. As the significance of the osseous defect was not appreciated at the time this patient was under observation, no effective treatment was instituted.

A résumé of the findings in the nine cases is given in the following tables:

TABLE I

REVIEW OF CASES OF PRESPONDYLOLISTHESIS

Total number	9
Males	7
Females	2
Ages 20 to 30	1
30 to 40	3
40 to 50	3
50 to 60	1
60 to 70	1
History of injury	3
No injury	6

TABLE II

RÉSUMÉ OF NINE CASES OF PRESPONDYLOLISTHESIS

Case No.	Name	Sex	Age	History of Injury	Duration of Symptoms	Subjective Symptoms	Objective Symptoms	Neurologic Symptoms	Roentgenographic Findings	Operated
1.	J. W.	M	33	Yes	2½ years	Backache.	Negative.	−	−	Yes
2.	O. L.	M	41	No	4 months	Backache. Difficult walking.	Lordosis. Tenderness at lumbosacral junction. Limitation of spinal motions.	−	+	Yes
3.	H. G.	M	64	No	4 weeks	Backache and right sciatica.	Negative.	−	+	No
4.	N. P.	M	41	Yes	6 months	Backache and right sciatica.	Difficulty in walking. Tenderness at lumbosacral junction. Limitation of lumbar movements. Flat back.	−	+	Yes
5.	N. D.	M	55	No	5 months	Backache.	Hollow back. Spinal motions free.	−	+	Yes
6.	F.McD.	F	29	Yes	2½ years	Backache and right sciatica.	Hollow back. Spinal motions free. Tenderness at lumbosacral junction.	−	+	Yes
7.	J. S.	F	43	No	6 months	Backache. Right sciatica. Numbness of outer part of right foot.	Increase in lumbar hollow. Restriction of lumbar movements. Tenderness at lumbosacral junction.	−	+	No
8.	J. P.	M	33	No	5 years	Backache. Pains in both lower limbs. Difficulty in walking.	Stiffness of lumbar spine. Tenderness at lumbosacral junction.	−	+	No
9.	T. T.	M	34	No	10 months	Backache.	Negative.	−	+	No

SYMPTOMATOLOGY AND FINDINGS IN NINE CASES OF PRESPONDYLOLISTHESIS

Backache was the chief complaint in all cases.

Sciatic pain was present in five cases.

Lordosis was found in four cases.

The neurological examination was negative in all cases.

Roentgenograms showed characteristic laminar defect in all but one case.

An operation was performed in five cases, all of which showed bilateral osseous defect of neural arch of last lumbar vertebra.

Four of the five patients who were operated on were relieved of their symptoms. The remaining patient is still in the hospital.

Although as yet there has not been recorded a case of prespondylolisthesis in which a dislocation of the affected vertebral body subsequently took place, the author believes that Dr. Armitage Whitman was correct in initiating this term and suggesting the existence of a lesion that is, in the light of our present knowledge of the anatomy of the lumbosacral area, undoubtedly the direct antecedent of a spondylolisthesis. Now that many orthopaedic surgeons are more carefully studying derangements of the back, it is but a matter of time when the sequence of a prespondylolisthesis—an injury, a dislocation of the body of the vertebra—will be witnessed and recorded.*

SUMMARY

1. Prespondylolisthesis is a competent cause of backache and back disability.

2. Prespondylolisthesis is the forerunner of a spondylolisthesis.

3. Prespondylolisthesis may remain asymptomatic for many years, or throughout life.

4. The most active period of life, thirty to fifty years, has shown the largest incidence of prespondylolisthesis in the author's group.

5. The chief clinical features of prespondylolisthesis are: (a) low back pain; (b) stiffness of back; (c) sciatic pain; (d) localized tenderness at the lumbosacral area. Lordosis is often present, but is not a constant finding.

6. The essential pathological lesion is a bilateral defect in the neural arch at the pedicles.

7. The most effective treatment is surgical, consisting of a fusion of the lower three lumbar vertebrae to the sacrum.

* It may be premature and even unwarranted to use the term prespondylolisthesis as expressing confident anticipation that a dislocation or spondylolisthesis will eventuate in the type of lesion herein described. However, a better term does not occur to the author and has not been suggested by anyone else, while the term prespondylolisthesis has already been used fairly extensively in both the English and German languages and may conveniently be applied to the clinical syndrome reported.

FRACTURES OF THE ANKLE: RECENT AND OLD*

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Fracture of the ankle comprises a good portion of the total number of fractures seen in any emergency service. Some recent articles on the subject are reviewed in the following table.

TABLE I
SUMMARY OF RECENT LITERATURE

Author	Cases	External Malleolus Alone	Both Malleoli	Internal Malleolus Alone	Posterior Malleolus With or Without Other Injuries
		Per Cent.	*Per Cent.*	*Per Cent.*	*Per Cent.*
Speed (1914)	208	28.7	22.6	4.8	7.7
Colvin (1914)	60	26.6	45.0	6.6	5.0
Ashhurst and Bromer (1921)	300	35.3	19.0	6.6	19.0
Platt *et al.* (1926)	116	28.0	55.0	12.0	3.0
MacKinnon (1928)	100	43.0	28.0	7.0	10.0
Ollerenshaw (1929)	100	44.0	29.0	14.0	7.0
Henderson (1931)	82	30.5	37.8	14.6	12.2
Bishop (1932)	300	36.3	45.0	15.6	13.0
Total	1,266	34.0	35.2	10.1	9.6

REVIEW OF CASES

For this survey, we have reviewed the histories of all the patients with fracture of the ankle treated in the Orthopaedic Section of The Mayo Clinic from 1909 to 1933. Patients seen within three weeks of the time of injury were considered as having fresh fractures, and all others as having old fractures. There was a total of 479 patients, of whom 139 had recent fractures of the ankle and 340 had old fractures.

Patients with recent fractures usually came to the hospital in emergency, but those with old fractures presented themselves because of the following symptoms, in the order named: (1) persistent pain in the ankle; (2) swelling; (3) limitation of motion; (4) deformity; or (5) weakness; or, they suffered from a combination of several of these complaints.

In all of these cases of recent and old fractures the mode of injury was interesting. Of the 139 recent fractures, thirty were produced by a fall from a height, twenty-three by slipping on the ice, eighteen by a direct blow on the ankle, eleven by automobile accidents, six by jumping

*Read before the American Orthopaedic Association at Washington, D. C., May 11, 1933.

from a runaway team, and the remaining fifty-one were produced by miscellaneous causes,—such as twisting ankle, tripping on stairs, and stepping in a hole. Of the 340 old fractures, ninety-two were produced by a fall from a height, forty-four by a direct blow to the ankle, twenty-nine by jumping from a runaway team, twenty-seven by slipping on the ice, eleven by automobile accidents, and the remaining 137 by twisting the ankle, tripping on stairs, stepping in a hole, and so forth.

Comparison of these figures reveals that the patients who came because of old fractures with persistent symptoms had suffered more severe types of injuries,—such as falling from a height or jumping from a runaway team. The incidence of injury sustained by slipping on the ice was two and a half times more common in cases of recent fracture. This was explained by the fact that all patients with recent fractures came from the vicinity of The Mayo Clinic,—that is, the north central part of the United States where there is ice during the long winters. Also a much higher percentage of old fractures were compound. As a consequence, these cases were complicated by more serious permanent injury to the bony components of the ankle joint.

TABLE II

RECENT FRACTURES OF THE ANKLE—139 CASES*
(LESS THAN THREE WEEKS AFTER INJURY)

Site of Fracture	No. of Cases	Per Cent.
A. Fracture of the malleoli		
1. Isolated		
a. Fibula (external malleolus)	29	20.9
b. Internal malleolus	15	10.8
2. Combined		
a. Low bimalleolar without displacement of talus	24	17.2
b. Bimalleolar with outward displacement of talus (Pott's)	28	20.1
B. Fracture of the weight-bearing surface of the tibia		
1. Isolated		
a. Posterior malleolus	3	2.1
b. Anterior margin	0	0.0
2. Combined		
a. Fracture of both malleoli and posterior malleolus of the tibia (trimalleolar, Pott's)	23	16.5
b. Anterior marginal or posterior fracture of the malleolus associated with fracture of one malleolus	10	7.2
C. Fracture of the astragalus		
1. Isolated	7	5.0
2. Combined†	(7)	
Total	139 (4 were compounded)	

* The Mayo Clinic.

† Combined astragalar fractures were associated with one of the foregoing malleolar fractures. These cases were so tabulated because the malleolar fracture was the dominant injury. (April, 1933.)

Another common condition in the old cases was diastasis of the lower third of the tibia and fibula, with rupture of the tibiofibular ligament. This distortion of the ankle joint often led to dislocation of the astragalus upward and outward, due not only to the diastasis but also to injury to the outer margin of the weight-bearing surface of the tibia. If such injury is extensive, permanent disability ensues.

In order to tabulate our cases according to the types of fracture we have adapted in principle the outline classification as devised by Tanton. It is simple, logical, and well suited to a clear presentation of a large group of cases.

TABLE III

OLD FRACTURES OF THE ANKLE—342 CASES*
(MORE THAN THREE WEEKS AFTER INJURY)

Site of Fracture	No. of Cases	Per Cent.
A. Fracture of the malleoli		
1. Isolated		
a. Fibula (external malleolus)	27	7.9
b. Internal malleolus	21	6.1
2. Combined		
a. Low bimalleolar without displacement of talus	68	19.9
b. Bimalleolar with outward displacement of talus (Pott's)	115	33.6
B. Fracture of the weight-bearing surface of the tibia		
1. Isolated		
a. Posterior malleolus	2	0.6
b. Anterior margin	8	2.3
2. Combined		
a. Fracture of both malleoli and posterior malleolus of the tibia (trimalleolar, Pott's)	56	16.3
b. Anterior marginal or posterior malleolar fracture associated with fracture of one malleolus	16	4.6
C. Fracture of the astragalus		
1. Isolated	29	8.4
2. Combined†	(23)	
Total	342 (34 were compounded; 2 were bilateral in the same patient)	

* The Mayo Clinic

† Combined astragalar fractures were associated with one of the foregoing malleolar fractures. These cases were so tabulated because the malleolar fracture was the dominant injury. (April, 1933.)

FRACTURES WITH DISPLACEMENT (POTT'S FRACTURES)

For convenience these classifications can be combined on a clinical basis and thus the relative frequency of certain types of fracture can be compared at a glance. Clinically Pott's fracture is a bimalleolar fracture with displacement, or, as Platt has described it, "those fractures of

TABLE IV

COMPARISON OF FREQUENCY OF CERTAIN TYPES OF FRACTURE

Type of Fracture	Fresh Fractures 139 Cases	Old Fractures 340 Cases
	Per Cent.	*Per Cent.*
Bimalleolar fractures with deformity	20.1	33.6
Trimalleolar fractures	16.5	16.3
Total Pott's fractures	36.6	49.9
Fracture of external malleolus alone	20.9	7.9
Fracture of internal malleolus alone	10.8	6.1
Fracture of the astragalus	10.0	15.1
Compound fractures	2.9	9.9

the lower 3 inches of the fibula, which are accompanied by rupture of the internal lateral ligament or fracture of the internal malleolus, and in which there is the slightest degree of deformity at the ankle-joint—either eversion alone or eversion combined with posterior displacement of the foot". In this summary we shall, therefore, group all bimalleolar fractures of this type together as Pott's fractures.

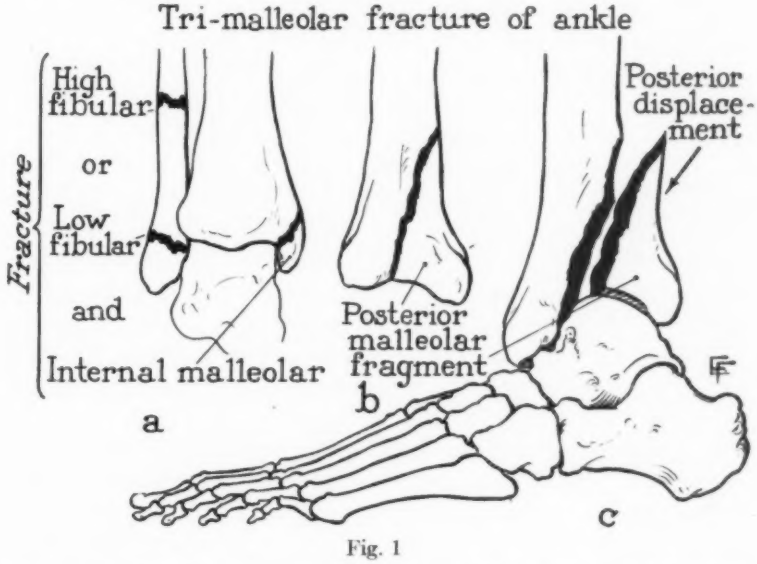

Fig. 1

The trimalleolar fracture, as identified and described by one of us (Henderson), consists of the clinical Pott's fracture, as mentioned, plus fracture of the posterior malleolus with encroachment on the weight-bearing surface of the tibia. It is usually accompanied by posterior and upward dislocation of the astragalus which manifests itself clinically as posterior displacement of the foot. This is not a new type of fracture, but the term "trimalleolar" is new and is offered as a descriptive name for an old fracture. It seems to describe tersely the lesion present in one of the most serious and disabling fractures of the ankle joint.

The posterior margin of the weight-bearing surface of the tibia, the posterior malleolus, projects well down over the posterior aspect of the astragalus and, in fact, is essential to prevent backward displacement of this bone. In addition, the astragalus is firmly connected with the external malleolus (the lower tip of the fibula) by a strong dense ligament, the posterior band of the external lateral ligament. This band never ruptures when injury is sustained, so that the astragalus and external malleolus are displaced together when fracture of the external malleolus takes place. This helps to explain the more frequent association of fractures of the internal and external malleoli when the posterior malleolus is fractured. In fact it is justifiable, when definite posterior dislocation of the foot is present, to assume that there is a trimalleolar fracture of the ankle.

CLINICAL CONSIDERATIONS AND TREATMENT

The diagnostic signs of uncomplicated fracture of the ankle are so obvious and so well known as to need no mention here. But a review of this type, with comparison of fresh and old fractures, emphasizes the importance of early accurate diagnosis. A certain percentage of fresh fractures gives little evidence of deformity at the time of injury. Therefore, the presence of pain and disability after any injury to the ankle demands careful consideration to prevent mistaken diagnoses. Too often, permanent disability may follow injury casually dismissed as a "sprain" in which roentgenograms are not taken. The swelling that may develop shortly after injury may mask even considerable bony displacement.

RECENT FRACTURES

The treatment of recent fractures is essentially conservative. Isolated malleolar fractures without displacement may be adequately treated by splinting or strapping. But in cases of deformity the method of choice is manipulation into corrected position and complete immobilization in a plaster cast.

Roentgenograms before and after reduction should always be taken in two planes. In the anteroposterior view the normal slight convexity of the weight-bearing surface of the tibia should fit accurately into the normal concavity of the superior articular surface of the astragalus. In the lateral view the converse is true. The convexity of the superior articular surface of the astragalus should fit accurately into the concave weight-bearing surface of the tibia. When these surfaces fit, as seen in the roentgenograms, the fracture is accurately reduced.

In sixteen of our 139 cases of recent fracture of the ankle, open operation was necessary. The replacement of a malleolus, usually the internal malleolus, by suturing or by the use of bone screws was necessary in cases in which there was considerable irreducible displacement of the fragments. Only one trimalleolar fracture was operated on. Even with considerable comminution of the weight-bearing surface of the tibia and the

resultant prolonged convalescence, an excellent result was ultimately obtained if the first reduction was proper and the line for weight-bearing accurate. On the other hand, as will be shown, when considering old fractures, neglect of this early accurate reduction leads to prolonged or permanent disability.

OLD FRACTURES

Patients with old fractures of the ankle came to the Clinic because of pain, swelling, limitation of motion, deformity, or weakness, or combinations of these symptoms. In the 340 cases in which there were 342 old fractures, operation was performed in 121 cases, osteotomy of both malleoli in forty, manipulation in sixteen, Achilles tenotomy in fourteen, astragalectomy in thirteen, removal of fragments or exostoses in twelve, "open reduction" in seven, wedge osteotomy in five, arthrodesis of the ankle in five, amputation in five, and bone graft to the malleoli in four.

In 219 cases conservative recommendations were made because the symptoms were not severe or because the injury was so great that there was little chance of improving function by surgical procedures.

In many of the cases of old fracture roentgenograms had not been made at the time of accident or later. However, in all fairness to the physicians who had seen these patients, there were many contributing factors,—such as inaccessibility to roentgen-ray equipment, and unwillingness of patients to submit to the examination. Furthermore, in many cases there was evidence of such severe injury to bone that any type of treatment would have given poor end results. Yet, even in cases of old fracture with marked deformity, it was often surprising, after treatment, to note the painless useful ankle which eventually resulted after years of disability. Improvement takes place slowly over a long term of years, and what had at first seemed to be a permanent and extensive loss of function finally resolved into comparatively little loss of function.

CONCLUSIONS

This review of 479 fractures of the ankle, comprising 139 recent fractures and 340 old fractures, emphasizes once more the importance of correct reduction to secure a sound useful ankle. Likewise it demonstrates that failure to effect perfect reduction through delay or failure to recognize the lesion inevitably leads to poor results and a high percentage of disability.

The trimalleolar fracture, in particular, with both lateral and posterior displacement of the foot if not reduced, is more likely to produce serious disability than is the bimalleolar type of fracture with only lateral displacement. Posterior displacement of the entire foot causes grave incapacity if uncorrected, and, even with operation later, its evil results are seldom rectified. Unlike the trimalleolar, the old bimalleolar fracture with valgoid deformity can often be successfully corrected by osteotomy if diastasis with injury to the outer border of the tibial pilon is not present.

The injury referred to is produced by diastasis of the tibia and fibula, with resulting rupture of the tibiofibular ligament and perhaps injury to the external margin of the tibia. The normal relation between the astragalus and the weight-bearing surface of the tibia is disrupted and, even with late corrective operation, there is a low percentage of satisfactory results.

We see, therefore, that corrective surgical measures on the improper results from old fractures of the ankle are far less important than early, accurate reduction followed by careful, adequate immobilization, and that the patient's ultimate happiness depends most on the physician who cares for him at the time of his injury.

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RECURRENT DISLOCATION OF THE JAW *

BY LEO MAYER, M.D., NEW YORK, N. Y.

Under this title two distinct pathological lesions have been included in the past,—one of them a genuine dislocation, the other an internal derangement usually associated with an abnormality of the interarticular fibrocartilage. Failure to analyze cases carefully has resulted in considerable confusion as emphasized by the number of different procedures, both non-operative and operative, which have been recommended for the cure of the condition.

Many patients complain of a slight sensation of snapping in the region of the temporomandibular articulation. This symptom has frequently been considered a neurotic manifestation. So far as can be decided from the superficial study accorded these cases, there is no specific pathology to explain them. They are usually cured by temporary fixation of the jaw, either by a bandage or splint. In a larger group of cases snapping is definitely due to malocclusion of the teeth and is readily cured either by filing down the offending molars or by other adjustments of the teeth. After excluding these two groups of cases, there remains a third group which is not due to neurotic tendencies or to malocclusion of the teeth, but to some intra-articular peculiarity of the temporomandibular articulation itself. It is with this group that this paper deals.

It is unnecessary to review in detail the anatomy of the temporomandibular articulation. It consists essentially of the condylar process of the jaw articulating with the temporal fossa of the temporal bone. The fossa is bounded in front by the eminentia articularis which normally forms a sufficient projection to prevent undue excursion of the jaw. Lying between the condylar process and the temporal fossa is the interarticular fibrocartilage,—a thin, fibrous plate which is attached quite closely to the condyle of the jaw and divides the articulation into a larger upper portion and a smaller lower portion. Both of these are lined with synovial membrane. Anteriorly the external pterygoid muscle is attached to the interarticular fibrocartilage. The joint is closed by a capsule which is reinforced by a number of accessory ligaments.

During the past few years it has been the author's good fortune to study five cases of slipping at the temporomandibular articulation. Operative procredures were carried out on four of these patients, affording him an unusual chance of studying accurately the underlying pathology. In three of the patients this was seen to be a genuine dislocation of the condyle of the jaw. When the mouth was opened, the condyle slipped forward over the eminentia articularis, lodging in an anterior position. In the fourth case no such dislocation occurred; the lesion was due entirely to an

*Read at the Annual Meeting of the American Orthopaedic Association, Washington, D. C., May 9, 1933.

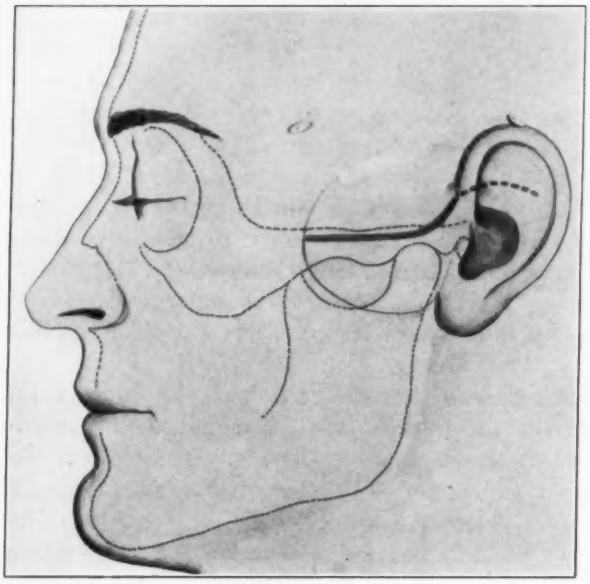

FIG. 1

Photograph of model illustrating the line of incision for bone-block operation.

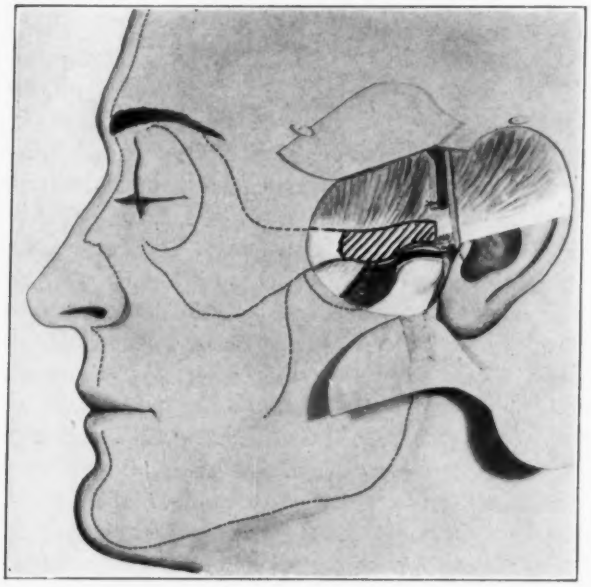

FIG. 2

Second step of bone-block operation. The superficial temporal vessels have been ligated, the nerve retracted posteriorly. The portion of the zygoma to be resected has been shaded. The interarticular fibrocartilage is shown in black.

abnormal laxity of the interarticular fibrocartilage. This case was treated simply by the removal of the meniscus, a method already practised by Ashhurst, Dufourmentel, and other surgeons. The other three cases, in which an actual dislocation occurred, required a more radical procedure.

Two methods for the cure of recurrent dislocation have already been published. First, that of Nieden, consisting of the transplantation of a strip of the temporal fascia, which is attached to the condyle of the jaw with sufficient tension to prevent the dislocation from recurring. Second, the method proposed by Konjetzny, in which the interarticular fibrocartilage is freed posteriorly and is lodged in the anterior portion of the joint in such a way as to form a buffer preventing the dislocation. Although both authors have reported satisfactory results, it seemed that the dislocation could best be

prevented by the bone-block method which has been so effective in overcoming genu recurvatum and drop-foot, since this method would actually correct the pathology,—namely, the excessive shallowness of the temporal fossa.

The operation is best performed under local anaesthesia. It is done through a two-inch horizontal incision running along the zygomatic process almost to the external auditory meatus, then gently upward and backward over the base of the pinna of the ear (Fig. 1). This incision was at first believed to be original, but it has already been used by Burdick, though not published by him. It has the advantage over the short horizontal and angular incisions of Murphy, Henderson, and others in that it gives an unusually good approach to the joint. This is done by turning the pinna of the ear downward, thus exposing the zygomatic process from its base

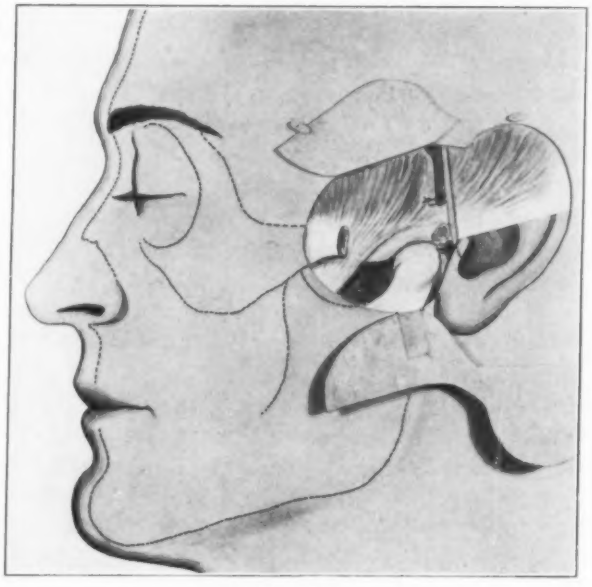

FIG. 3

Third step of the bone-block operation. A portion of the zygoma has been resected exposing the entire temporomandibular articulation. The interarticular fibrocartilage has been removed.

FIG. 4

Fourth step of bone-block operation. The bone graft has been mortised into the temporal bone just anterior to the eminentia articularis. The projecting portion of the bone graft has been shaded.

posteriorly to a point anterior to the temporomandibular joint (Fig. 2). This approach has one disadvantage; it necessitates the division of the superficial temporal vessels, which run vertically just anterior to the ear, and also necessitates strong retraction of the superficial temporal nerve, a branch of the fifth cranial nerve supplying sensation to the lateral portion of the forehead. Even though the nerve is cut or injured, however, the sensory loss is so slight as to be of little practical significance. About one inch of the zygomatic process is cut away with the motor saw or with any suitable bone-cutting instrument (Figs. 2 and 3). This at once exposes the temporomandibular joint. The capsule of the joint is divided by a transverse incision or by a transverse combined with a vertical. It is then possible to study the exact pathology of the particular case. The patient is asked to open the mouth and during this act the motions of the condyle and of the interarticular cartilage can be accurately observed. In one of the four cases operated upon the pathology was due entirely to a loose cartilage and as soon as this had been removed the snapping stopped. In the other three cases, despite preliminary removal of the meniscus, the condyle could be seen slipping forward over the eminentia articularis as the mouth was opened. To prevent the slipping from occurring the resected portion of the zygomatic process is utilized as a bone graft and inserted just anterior to the eminentia articularis. A vertical groove exactly corresponding in size to the width of the bone graft is cut in the temporal bone. Its depth should correspond to the thickness of the graft (usually about one-eighth of an inch). The groove is about one-half an inch long, permitting one-half of the graft to project downward (Fig. 4). In cutting the groove, the edges should be made slightly oblique so that the graft will be firmly mortised in place when driven into position. No fixation sutures are necessary. When the graft is in place the patient is again allowed to open the mouth and if the technique has been correct a slipping will be prevented by the bone graft. The operation is then completed by a careful suture of the capsule of the joint, closure of the fascia and of the skin. That portion of the zygomatic process which was resected for the exposure of the joint is usually just the right size for the bone block. It is unnecessary to replace the resected zygoma since this defect is not noticeable either in the appearance of the face or the function of the jaw. Great care must be taken in this operation, as in all operations on the temporomandibular joint, not to injure the branches of the facial nerves which cross upward over the anterior portion of the zygomatic process. Morris has pointed out that, since these branches are running deep to the fascia, injury can be made less probable by thorough retraction of the temporal fascia. At the conclusion of the operation a plaster-of-Paris helmet, completely encasing the head, is applied so as to prevent motion of the jaw until the graft has healed in place. Thus far immobilization of from four to six weeks has proven adequate. The patients are given a liquid diet for the first ten days. It has not been necessary to remove teeth for feeding, since the plaster, though snug, permits

the passage of a glass tube between the teeth. After ten days the patients are able to open the teeth sufficiently to eat soft food.

Thus far the bone-block method has been used in three cases. In all three the condition of slipping caused marked disability not alleviated by careful non-operative treatment. In all three cases the bone-block method has been successful.

A synopsis of the three cases follows:

Case 1. K. F., No. 15191, aged twenty-seven years, was admitted July 19, 1927, discharged September 2, 1927. For many years the patient had had a recurrent dislocation of the left jaw which occurred whenever he laughed or yawned and frequently during the act of eating. Pain was a comparatively slight symptom, but the patient was much annoyed by the loud snapping sound and the necessity of reducing the dislocation. Examination showed nothing abnormal except a dislocation of the jaw whenever the patient opened his mouth. A bone-block operation was performed July 27, 1927. The plaster was removed August 18. The patient was given physiotherapy and allowed to leave the hospital September 2. Two years later there had been no recurrence of the dislocation; there was almost normal motion of the joint. A small area of hyperaesthesia over the lateral aspect of the left forehead was still present.

Case 2. B. S., No. 17221, aged twenty-two years, was admitted January 26, 1928, discharged February 7, 1928. Onset of condition occurred three years before without any apparent cause. The patient complained chiefly of pain in the region of the left temporomandibular joint. A few months later the first dislocation was noted. Recurrences then became more and more frequent, and at the time of the examination the patient was having a dislocation almost every day. Examination was negative except for tenderness in the region of the left temporomandibular joint. When the patient opened the mouth the condyle slipped out of the temporal fossa. A bone-block operation was performed January 27, 1928. At follow-up, one year later, the patient reported that there had been no recurrence of the dislocation. For several months there was a restriction in the motion of the jaw limited not only to opening and closing, but also to lateral motion. This gradually disappeared by means of exercises and manipulation until one year after operation there was normal motion of the jaw.

Case 3. G. S., No. 42025, aged twenty-six years. For many years the patient has been suffering from a slipping of the left temporomandibular joint. During the last few months slipping has occured each time the patient opens her mouth, causing her great pain and discomfort. Examination shows typical dislocation of the mandible whenever the patient opens the mouth. This is confirmed by roentgenograms of the mouth with the joint closed and open (Fig. 5). A typical bone-block operation under local anaesthesia was performed on March 20, 1933. Immediately after the bone block had been mortised into position the patient was unable to dislocate the jaw. Plaster-of-Paris was removed after four weeks. Roentgenograms showed good position of the bone block (Figs. 6 and 7). Three months after operation the patient was able to open the mouth to the normal limit. She had no pain and there had been no recurrence of dislocation.

The fourth operative case, in which the lesion was entirely confined to the interarticular fibrocartilage and was cured by the removal of the cartilage, is as follows:

Case 4. E. E., No. 24357, aged eighteen years, was admitted September 16, 1929, discharged September 27, 1929. For one and a half years the patient had been complaining of a clicking in the region of the right temporomandibular joint, occasional inability to open or close the mouth, and pain in the region of the joint. The patient believes that her symptoms started when she was given a hard slap on the right side of the face. Immediately following the blow she was unable to close her mouth and felt severe pain in the region of the temporomandibular joint. By pushing the jaw toward the right side

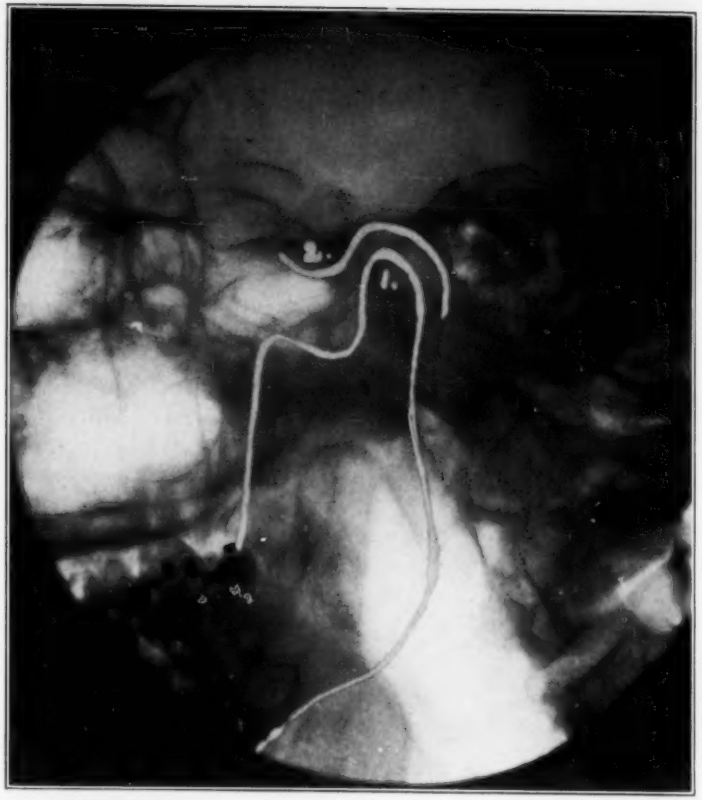

FIG. 5-A

FIG. 5-B

Roentgenograms of Case 3 before operation. The outlines of the jaw and of the temporal fossa have been traced in white ink for purposes of reproduction.

1. Condylar process. *2.* Eminentia articularis.

The roentgenogram at the left was taken with the mouth closed and shows the condylar process within the temporal fossa. The roentgenogram at the right was taken with the mouth open and shows the condylar process dislocated forward, lying in a position just anterior to the eminentia articularis.

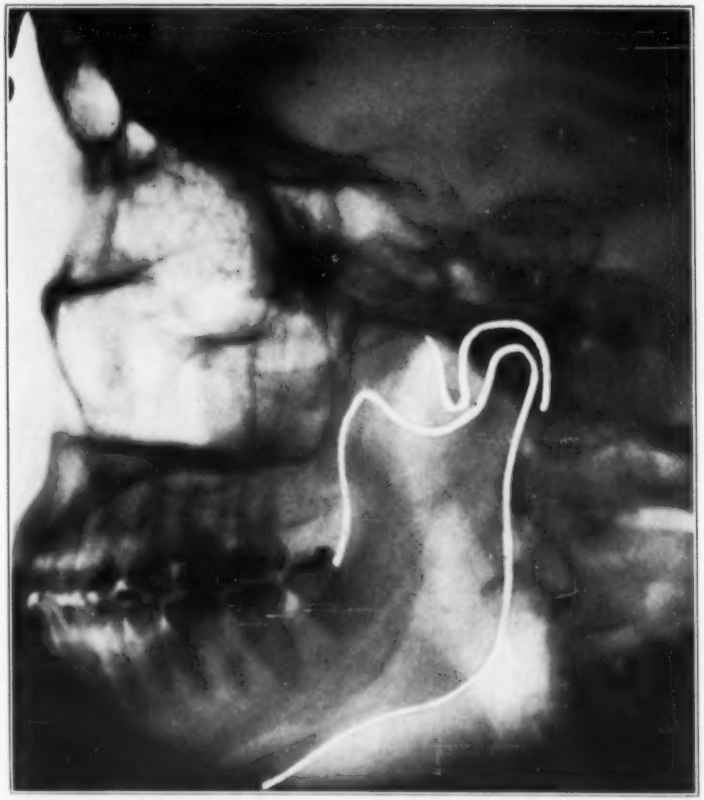

FIG. 6

Roentgenogram of Case 3, four months after operation, with the mouth closed. The deepening of the temporal fossa by means of the bone block is clearly seen.

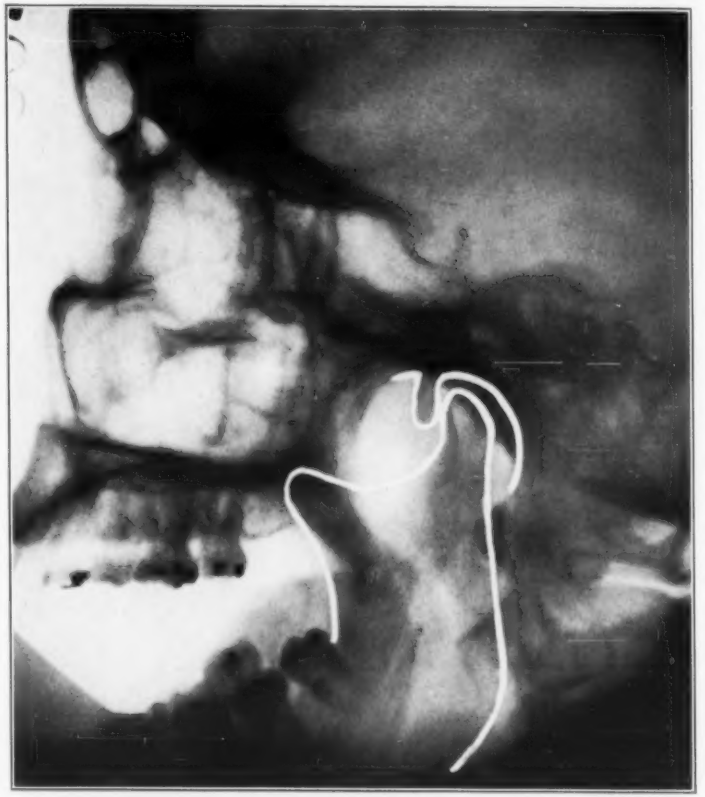

FIG. 7

Roentgenogram of Case 3, four months after operation, with the mouth open. It is seen that the bone block effectually prevents the condyle of the jaw from dislocating.

she was able to close it. Since that time the slipping had become more and more frequent.

Examination showed no abnormality except a snapping sensation in the region of the right temporomandibular joint when the mouth was opened and closed. The patient voluntarily could make the jaw lock and then release it. No definite dislocation could be palpated nor could it be demonstrated by roentgenograms of the joint. An operation was performed September 18, 1929. On opening the joint the interarticular fibrocartilage was found detached in large part from the condyle. This gave it an abnormal degree of mobility. It was readily removed by cutting its anterior and posterior attachment to the condyle. The temporal fossa appeared to be normal. After removal of the cartilage the patient could open and close the mouth without any snapping. Plaster-of-Paris was applied as in the bone-block operations and left in place for three weeks. There has been no recurrence of the snapping; pain disappeared and has not recurred.

SUMMARY

Intractable slipping at the temporomandibular articulation may be due either to a lesion of the interarticular fibrocartilage—corresponding to a lesion of the internal meniscus of the knee—or to an actual dislocation of the condyle which slips forward over the eminentia articularis. The former group can be cured by the simple removal of the meniscus. For curing the latter group, a new operation is described, consisting in the construction of a bone block just anterior to the eminentia articularis. Four cases of cure are cited,—one of the first group, three of the second.

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INSTABILITY OF THE KNEE JOINT DUE TO INJURY OF THE ANTERIOR CRUCIAL LIGAMENT

A Report of Eleven Operated Cases *

BY ARTHUR KRIDA, M.D., F.A.C.S., NEW YORK, N. Y.

Injuries to the crucial ligaments are sustained when the knee is subjected to gross dislocation or subluxation, or by the exaggeration of the type of traumatism that produces injuries to the semilunar cartilages. Either or both ligaments may be the seat of rupture, or the traumatism may result simply in attenuation and stretching. Injury to the anterior crucial ligament is by far the more common, only a few cases of posterior crucial injury having been reported in the literature.

That recovery from such injuries may result in a functionally useful and stable joint admits of no question. It must be assumed that when such functional recovery occurs the stability of the joint is determined by the integrity of the quadriceps extensor muscle and its fascial expansions. Therefore it should be stated that cases of acute injuries to these ligaments are not suitable for plastic repair.

Not infrequently, however, following such an injury, the knee joint becomes the seat of a chronic instability. The instability may be general in character,—that is, in the lateral as well as in the anteroposterior planes; or the instability may be specific with regard to the particular ligament involved. The characteristic instability associated with injury to the anterior crucial ligament consists of the ability to displace the tibia forward on the femur in the attitude of extension or of slight flexion. The characteristic instability associated with damage to the posterior ligament consists in the ability to slide the tibia backward on the femur in the flexed position.

A patient with a chronic knee-joint instability based upon such injuries is very much disabled. The usual alternatives with which he is faced are: (1) permanent brace wearing; (2) arthrodesis; (3) the prospect of operative reconstruction of the damaged ligament.

The historical summary of the attempts at surgical repair of these ligaments prior to 1917 is contained in the paper of Hey Groves.[1] These consist in the main of direct suture of the ligaments or of the reattachment of avulsed bony fragments bearing the ligament. In 1917, Hey Groves [2] described a fascioplastic repair based upon entirely new conceptions. The principles involved in the Hey Groves operation consist of: (1) the use of fascia lata to replace the ligament; and (2) the firm anchorage of the reconstructed ligament in bone tunnels drilled through the femur and the tibia. In the writer's opinion, these principles have served to establish

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FIG. 1
General utility incision for exploration of knee joint.

firmly the operative treatment of these injuries.

The Hey Groves operation for the repair of the anterior crucial ligament is done through a J-shaped incision, the long arm extending upward on the lateral aspect of the thigh and the curved portion cutting across the anterior joint structures. A one-quarter-inch drill hole is made in the outer condyle of the femur to emerge in the intercondyloid notch. A similar drill hole is made in the inner tuberosity of the tibia to emerge somewhat anterior to the normal site of the insertion of the anterior crucial ligament. A long strip of fascia lata, about one to one and one-half inches in width, is then reflected downward and allowed to remain attached at its lower pole. This is introduced into the joint and is then passed through both drill holes and, with the knee in slight flexion and the fascial strip under tension, is attached to the periosteum of the head of the tibia. Alwyn Smith [3] added a valuable feature to the operation by using a somewhat longer strip of fascia and, after suture to the tuberosity of the tibia, reflecting the end of the fascial strip upward onto the inner condyle of the femur, thus reconstructing an internal lateral ligament.

The writer's experience has been entirely with the repair of the anterior crucial ligament, no case of posterior crucial ligament having come under his observation. The above described combined operation has been modified by the writer in the following manner:

(1). The joint is opened by what has been described as a general utility incision for the exploration of the knee joint.[4] This incision begins in the mid-line well above the patella, curves downward along its inner border, and passes downward along the side of the patellar ligament. The capsule is opened in the same plane.

(2). The fascia is secured through a separate incision on the outer side of the thigh.

(3). The method of attaching the reconstructed lateral ligament to the condyle is a modification of the Alwyn Smith procedure. Instead of fastening it through drill holes, this strip is anchored to the femur

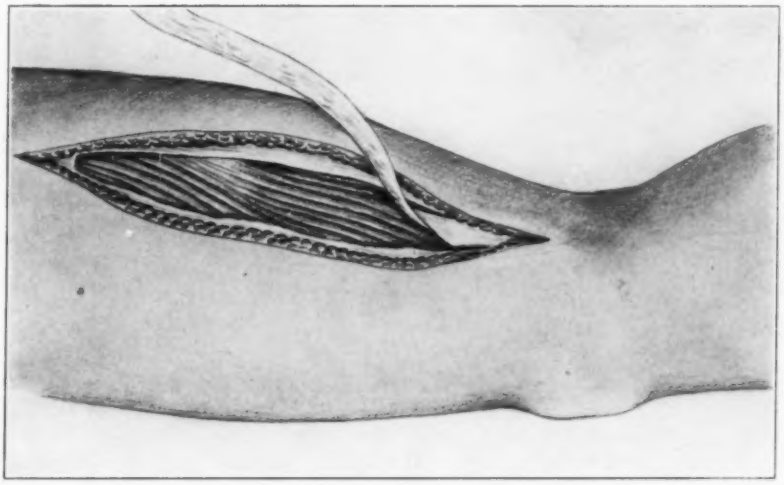

FIG. 3

A long strip of fascia lata is secured and allowed to remain attached at its lower pole.

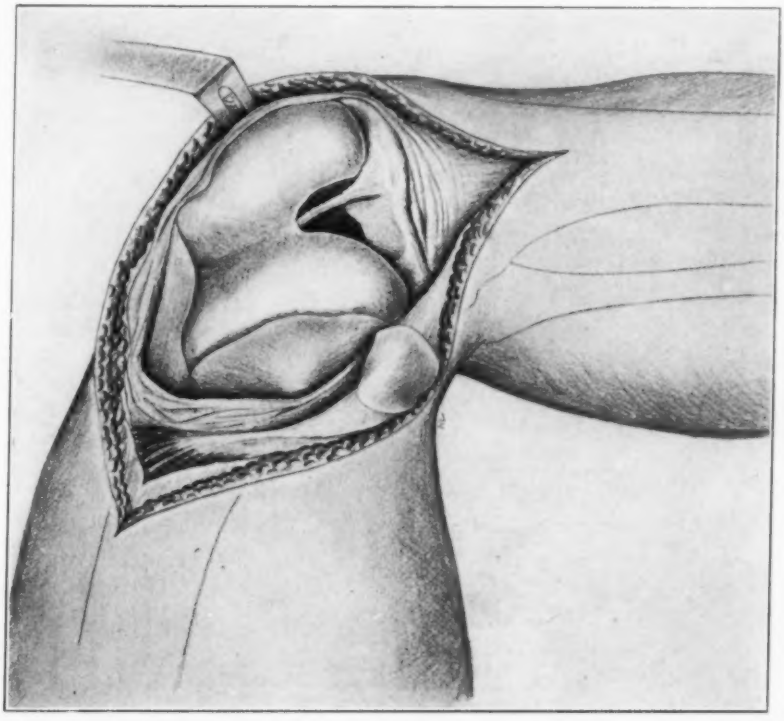

FIG. 2

Knee joint exposed, showing thinned, frayed-out, anterior crucial ligament.

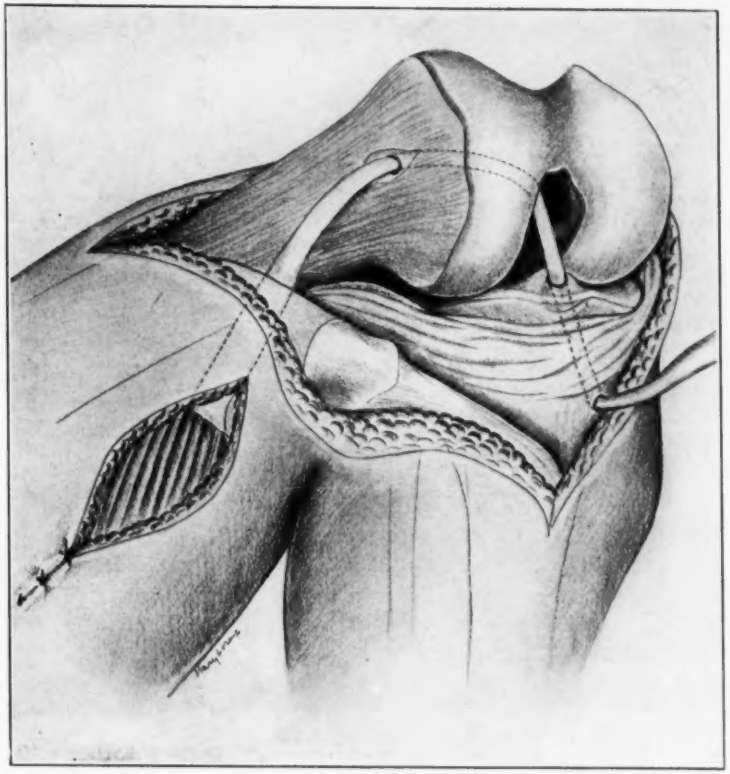

FIG. 4
Course of fascial strip through bone tunnels of knee joint.

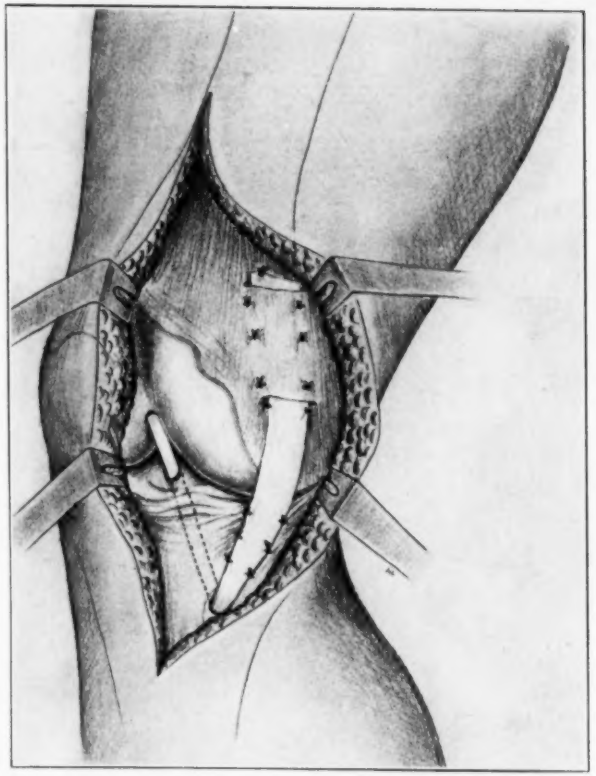

FIG. 5
The end of the fascial strip is used to reconstruct the lateral ligament.

subperiosteally. Two small transverse incisions are made down to the bone and the periosteum between them is lifted up. The strip is passed through the incisions beneath the periosteum, and sutured to the soft parts.

The after-treatment consists of relative immobilization in a Thomas splint with the knee in slight flexion. Exercises of the quadriceps are encouraged from one week after the operation. The patient begins to mobilize his knee at the end of four weeks and is allowed to walk without a brace or other support at the end of six weeks.

During the last eight years, the author has operated upon eleven patients for the reconstruction of the anterior crucial ligament. The youngest patient was eighteen; the oldest, forty-three. There were ten men and one woman. All the patients except two were very much disabled prior to operation; in general they required the use of a brace or were able to get about only with the aid of a stick. In one case the ruptured ligament was discovered during an exploratory operation for internal derangement; one other patient had a "trick knee",—he could voluntarily slide the tibia forward upon the femur to the extent of one inch, although the knee was otherwise stable and did not require the use of a support. Two cases presented the additional symptom of hyperextension to about twenty-five or thirty degrees.

There were no infections nor any postoperative complications in the series. At operation, the anterior crucial ligament was found to be completely ruptured in three cases; in the remainder, varying degrees of attenuation and relaxation were noted.

In discussing the results obtained in this series, it may be stated that the evaluation of a result should not ordinarily be made under six months, since these knees improve in range of motion and in strength up to that time, and even later. One case is classed as a failure,—a confirmed compensation case, in which the patient was a negro thirty-six years of age who had worn a long brace for two years, and whose knee joint presented moderately advanced osteoarthritic changes. Even though he obtained a good range of motion and a stable knee, he continued to complain of disability, and the result was therefore classed as a failure. One patient left the country at the termination of his hospital stay, which happened to coincide with a lump sum settlement of his case. It has not been possible to follow him. One patient was operated upon ten weeks ago, and the operation promises to be successful.

The remaining eight cases are classified as good results. The patients have stable, painless knees with substantially complete ranges of motion, except one in whose knee flexion is limited to fifteen degrees beyond a right angle at the end of one year. As a further illustration of the general efficacy of this operation, the two cases presenting well marked hyperextension may be mentioned. This distortion, ordinarily difficult to relieve by operative measures, was completely controlled in both cases.

In conclusion, it may be said that the anterior crucial ligament

plays a vital rôle in the type of knee-joint instability here described. The operation for the reconstruction of that structure is apparently accompanied by no more risk than obtains in the average operation upon the knee joint. The results of the operation are sufficiently encouraging to warrant the statement that any patient of suitable age, with a grossly unstable knee joint of traumatic origin, and without too pronounced secondary changes in the joint, can be given a reasonable assurance of relief from his disability.

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FRACTURES OF THE HUMERAL CONDYLES IN CHILDREN *

BY J. S. SPEED, M.D., AND H. B. MACEY, M.D., MEMPHIS, TENNESSEE

Some very interesting facts have been brought out by a study of the results obtained in the treatment of a series of approximately 120 fractures of the humeral condyles in childhood which occurred before the ossification of the epiphyses at the lower end of the humerus. The cases were seen either at the time of the acute fracture, or in later life because of complications which impaired the use of the arm.

The type of fractures included are only those of the internal and external condyles, the detached fragment carrying with it the trochlear or capitellar portion of the articulation. Avulsions of the internal epicondyle are also included, as the problems involved in their treatment are essentially the same. They are to be clearly differentiated from the usual supracondylar fractures, so common in children, which offer an entirely different problem, both as regards the treatment and the results obtained. This distinction between condylar fractures and supracondylar fractures of the humerus is just as vital for a true understanding of the problems involved in their treatment as that between central fractures of the neck of the femur and trochanteric fractures.

If a supracondylar fracture is reasonably well reduced, union takes place with very little, if any, limitation of function in the joint or disturbance in the future growth of the epiphyses.

Experience has shown us that such is not the outlook for condylar fractures. Non-union or malunion of the detached fragment is almost universal with the ordinary closed reduction. This is followed by a sequence of complications. Increasing deformity and distortion of the elbow joint occurs, due to the failure of the affected condyle to develop because of delayed or arrested epiphyseal growth. The result is a cubitus valgus or varus deformity and an unstable joint which often becomes painful after use and in later years is frequently associated with a delayed ulnar palsy. Limitation of motion is the rule in the early years following the fracture and may persist, although many cases develop a full range of motion.

If these complications are to be avoided, immediate accurate reduction of the fracture with close coaptation of the fractured surfaces must be accomplished; otherwise the nutrition of the fragment is impaired and distortion of the epiphysis is unavoidable.

There are certain factors connected with condylar fractures which necessitate a clear view of the fragments to insure a proper reduction, and some dependable type of internal fixation to maintain this position once it has been secured. These factors are as follows:

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Attached to the internal condyles and external condyles respectively are the strong flexor and extensor group of forearm muscles. When either condyle loses its bony anchorage the pull of these muscles displaces it, often turning the condyle end over end and rotating it, if the fracturing force is strong enough to carry the forearm into extreme abduction or adduction. In such cases it is impossible to replace the fragment in its proper position by any type of closed manipulation. Success depends upon a clear view of the entire articular surface of the humerus and free access to the fragment, which must be turned and manoeuvered about, and fitted back into its proper position like the pieces of a jig-saw puzzle. The pull of the attached muscles often makes this difficult even under direct vision. When the reduction is obtained, its insecurity and the ease with which the fragment is displaced can be demonstrated by putting the attached muscles under tension by slight movement of the forearm. The least pull displaces the fragment. A study of the subsequent results in these fractures has shown that even minor displacements of the condyles are incompatible with satisfactory function,—malunion, non-union, and growth disturbances impairing the future use of the joint. It is necessary, then, to use some type of dependable internal fixation which will not allow the fragment to slip and which will hold the fractured surfaces in close apposition if proper union is to be obtained.

We have tried many types of internal fixation, including absorbable sutures, steel wire, bone screws, etc., but have found that the simplest and most reliable is the ordinary wire nail. It fulfills all the requirements for fixation, is easily inserted, apparently does not materially damage the epiphyseal area, and can be easily removed with local anaesthesia at the end of a few weeks when union is solid enough to maintain position.

It is necessary in many cases to drive the nail through the epiphyseal growth line. In such cases the theoretical objection cannot be denied that it is undesirable to leave a foreign body through the epiphysis for so long a time. Practically, however, no irregularity in growth or premature ossification of the epiphysis has been observed following the use of the nail. Certainly, as far as the future fate of the epiphysis is concerned, the advantages attained by prompt and accurate union of the condyle greatly outweigh any damage that the nail may do.

In order to insure a better understanding of the problems involved in treating these fractures, it will be helpful to give a brief description of the muscular attachments to the humeral condyles and a résumé of the ages at which ossification of the various epiphyses takes place.

The lateral epicondyle appears at the thirteenth year, and fuses at the sixteenth or seventeenth year. It gives attachment to the radial collateral ligament and to the tendon of the common origin of the supinator longus and to the following extensor muscles:

1. Extensor carpi radialis longus.
2. Extensor carpi radialis brevis.
3. Extensor communis digitorum.

4. Extensor digiti quinti proprius, which arises with the extensor communis digitorum.
5. Extensor carpi ulnaris.

The capitellum appears at the end of the second year, extends medialward to form the chief part of the articular end of the bone, and fuses at the sixteenth year.

The anconeus arises from the back part of the epicondyle and condyle.

The medial epicondyle appears at the fifth year and fuses at the eighteenth year. It gives attachment to the ulnar collateral ligament, pronator teres, and to a common tendon of origin of the following flexor muscles:

1. Flexor carpi radialis.
2. Palmaris longus.
3. Flexor sublimis digitorum (humeral head).
4. Flexor pollicis longus (may arise from medial epicondyle).
5. Flexor carpi ulnaris (humeral head).

The center for the medial part of the trochlea appears about the twelfth year and fuses at the sixteenth year.

For convenience of description and study, the fractures have been grouped into the following classes:

1. Incomplete fractures of the internal and external condyles without displacement.
2. Fractures of the condyles with displacement, treated by closed reduction.
3. Reconstruction operations for the relief of disability following old fracture.
4. Fractures of the condyles with displacement, treated by delayed open reduction (after three weeks).
5. Acute fractures of the condyles with displacement, treated by immediate open reduction and internal fixation.
6. Avulsions of the internal epicondyle:
   a. Treated by closed reduction.
   b. Treated by open reduction and internal fixation.
   c. Late cases treated by removal, ulnar nerve transplantation, etc.

INCOMPLETE FRACTURES OF THE CONDYLES WITHOUT DISPLACEMENT—NINETEEN CASES

This group was included for study because it was thought that these cases might help in determining the true cause of the various complications so common in complete fractures with displacement. The patients were followed and checked by roentgenograms for a sufficiently long period of time to warrant the belief that a perfect functional result was to be anticipated. We have recently been fortunate in getting a number of the patients back for a check-up after periods of from two to twelve years. All of them have shown perfect anatomical and functional results and in

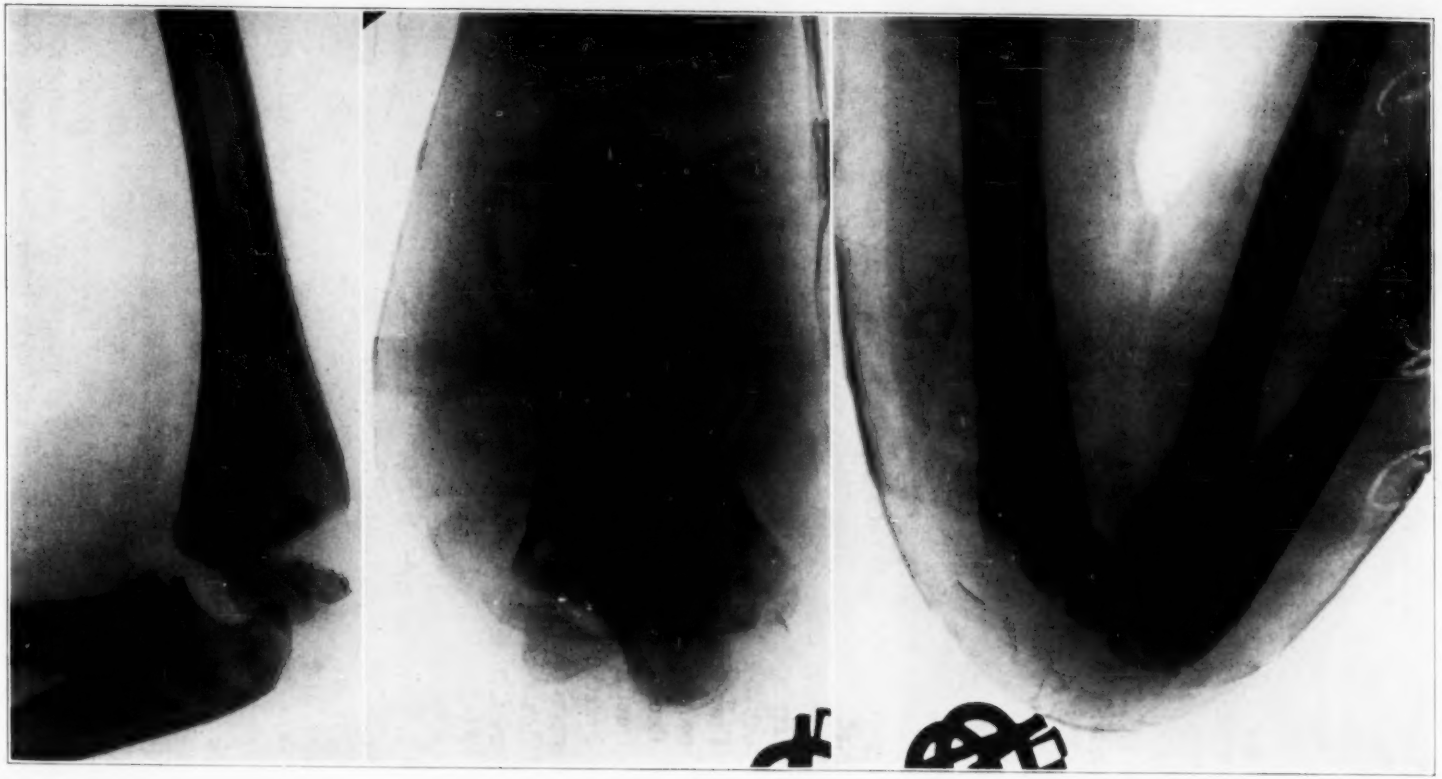

FIG. 1

Case 1. Fracture of the external condyle with moderate displacement. Treated by closed reduction. Relatively good position.

FIG. 2

Case 1. Ten months later. Non-union with epiphyseal changes. Poor functional result. Illustrates uncertainty of closed reduction.

no case have late roentgenograms shown any irregularity in epiphyseal growth or premature ossification of the epiphyses It is to be concluded then that it is not the dissolution of bony continuity that produces the epiphyseal changes seen in the types of fractures with displacement of the fragments. Further reasoning would indicate that, if we were able to replace accurately the displaced fragments immediately after the injury, we could expect to obtain very much the same satisfactory results.

COMPLETE FRACTURES OF THE CONDYLES WITH DISPLACEMENT, TREATED BY CLOSED REDUCTION—FIFTY-NINE CASES

This group, by far the largest, includes all of our own acute cases treated by closed reduction, and all those cases treated in the acute stage elsewhere and coming to us later because of unsatisfactory results.

It has been aptly said that we learn most by our own mistakes and the poor results of others. If so, this group should be a storehouse of information. It is true, of course, that we do not know how many good results may be obtained elsewhere by the closed method, for we naturally never see them, but it is certain that there must be something wrong with a method that produces so many bad results.

Our own experience with the closed method in acute cases leads us to believe that the percentage of good results is relatively low, and that those cases that come out satisfactorily are more the result of good fortune than good management.

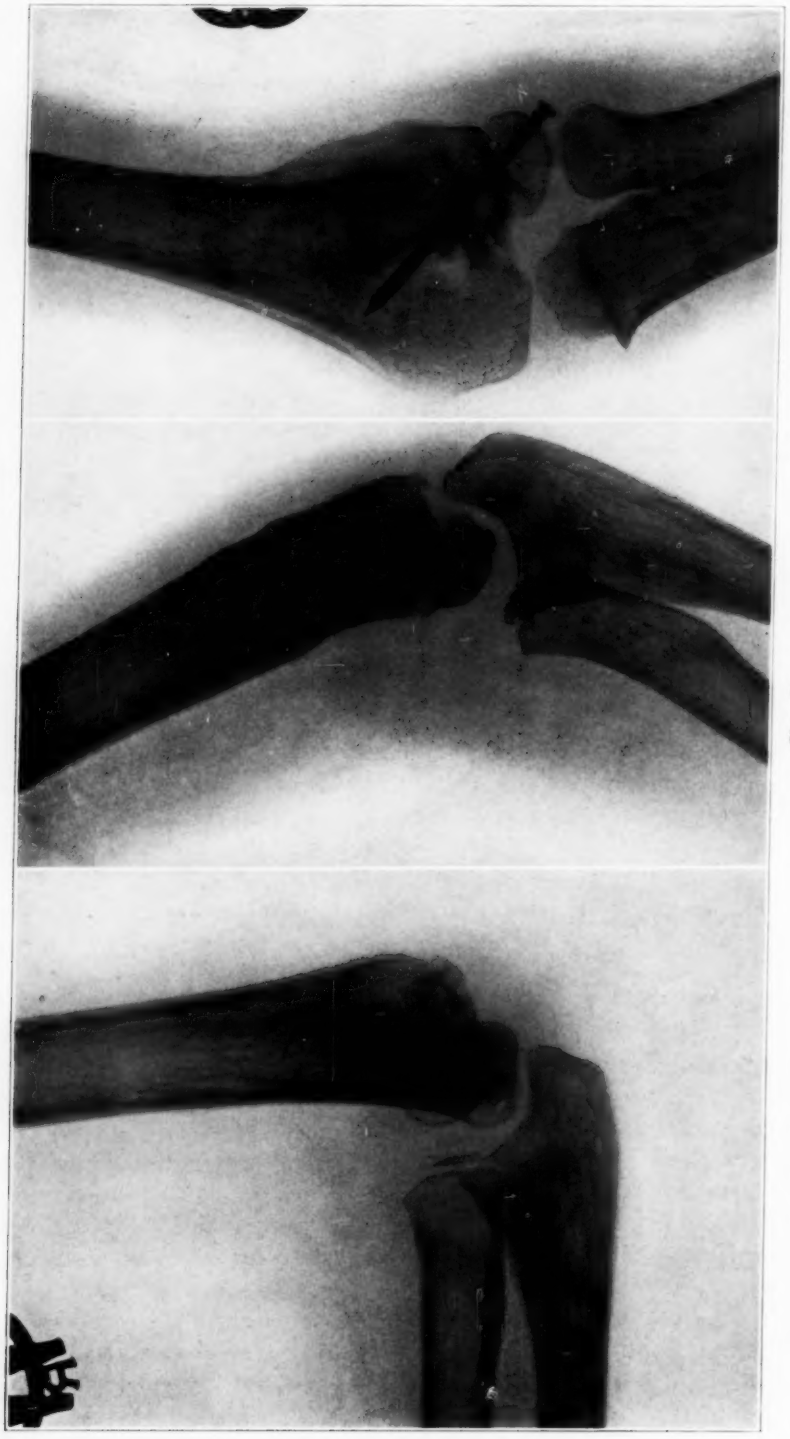

FIG. 3

Case 2. Delayed open reduction of external condyle, three weeks after fracture. Fixation with wire nail.

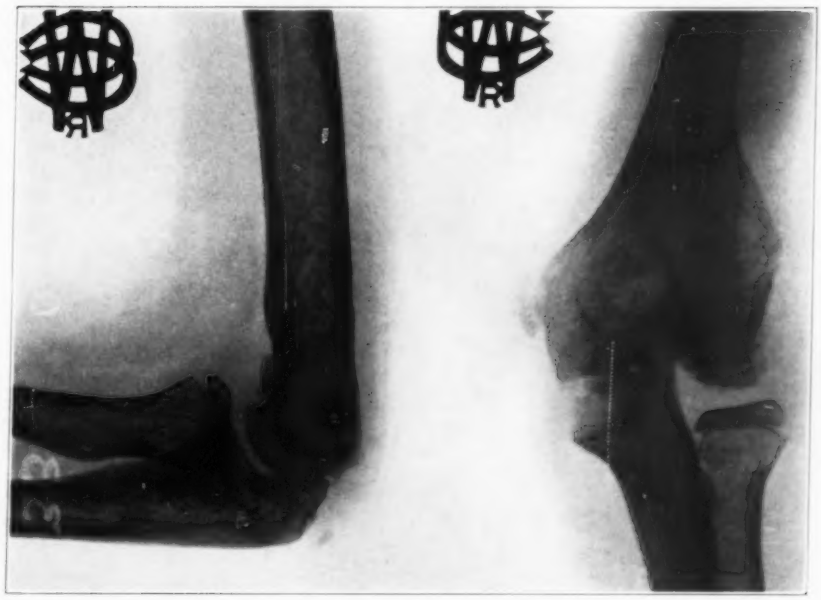

FIG. 4

Case 2. Two and one-half years later, showing bony union, but with epiphyseal changes and some distortion of the capitellum.

The conclusions from a study of the acute group may be summarized as follows: Cases where the detached condyle is only moderately displaced and not rotated can frequently be reduced satisfactorily and a good result obtained. However, subsequent displacements of greater or lesser extent are liable to occur; if so, we are all human enough to accept it, hoping that the result will not be so very bad. Even if we have the courage to advise open reduction after ten days or two weeks, valuable time has been lost. If there is wide separation of the fragments accompanied by rotation or tumbling end over end, closed reduction is extremely difficult or impossible, and the average case will be reduced with inexcusable displacement and irreparable damage to the elbow joint. Of course, the competent surgeon will not accept such a result, and when he finds the closed reduction unsuccessful will do an open reduction then or a few days later, but he should be aware at the beginning of the difficulties of reduction and the probability of subsequent displacement with the closed method and not waste time attempting it. Exceptions prove the rule. There were a few such fractures in this series that were reduced and good results obtained without open reduction, but this procedure is certainly not to be advocated.

The next group are those cases which come in late, several weeks or months after the injury, with only a moderate displacement. In these it is questionable whether a better result will be obtained by leaving them alone or by doing a delayed reduction. Subsequently it will be shown that delayed open reductions are far from satisfactory; union in good posi-

FIG. 5

Case 3. Acute fracture of the external condyle, treated by open reduction. Internal fixation with wire nail.

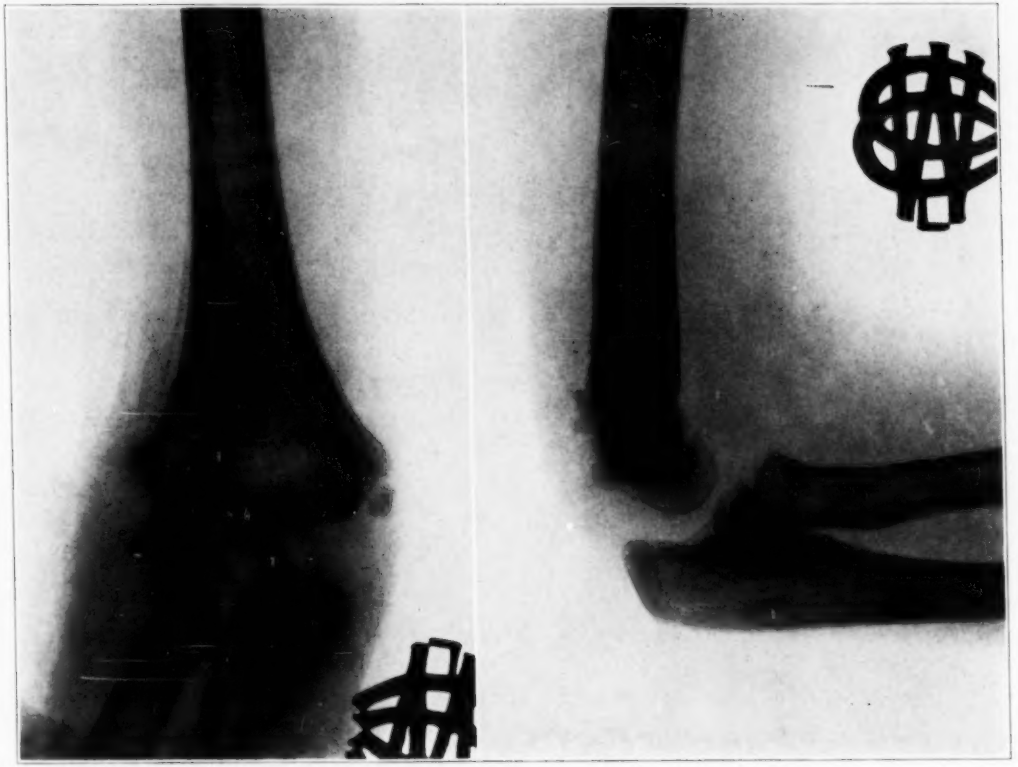

FIG. 6

Case 3. Three weeks later, showing perfect reduction.

FIG. 7

Case 3. Two years later, showing slight irregularity in external condyle, but normal growth. No epiphyseal disturbance; excellent function.

tion can be secured, but subsequent epiphyseal changes are common. If the fragment is united in reasonably good position it is probably better to leave it; if it is not united, or if it is in malposition, the result can be improved by open reduction.

The group which is by far the largest includes all those cases in which the patients come in years after the fracture, seeking relief for disabilities and deformities which have resulted from unsuccessful closed reductions. They consist of non-unions and malunions of either condyle, often with extreme deformity. While many of the elbows are relatively satisfactory for light use, any unusual exertion or trivial injury produces pain and tenderness about the joint. This is easily understood from a study of the roentgenograms which show distortion of the joint, condyles displaced with fibrous union, or complete non-union with marked retardation of growth on the affected side of the humerus. Motion is usually very much restricted in the early years following the fracture and this may persist into adult life, particularly when malunion has resulted. In many other fractures, however, the range of motion gradually increases until in adult life it may equal that of the normal joint. It is surprising sometimes to see joints which, in the roentgenogram, look hopelessly distorted, moving painlessly through practically the normal range of motion.

Many patients with extreme cubitus valgus deformities and ununited or malunited external condyles, who came in for the relief of a delayed ulnar neuritis, were so well satisfied with the use of the elbow that no treatment of the bony deformity was sought or considered advisable.

RECONSTRUCTION OPERATIONS

In those cases, however, where there was persistent pain and instability of the joint or where motion was seriously impaired, some type of reconstruction operation was necessary. The indications for such operations were as follows:

1. Deformity.
2. Continuous pain or recurrent attacks of pain following unusual exertion.
3. Instability, rarely seen.
4. Limitation of motion.
5. Delayed ulnar neuritis.

A simple wedge-shaped supracondylar osteotomy is sufficient to correct the deformity in certain cases where the fractured condyle has united in good position with satisfactory motion, but where an inequality in the growth of the condyles has resulted from an epiphyseal disturbance.

Complete removal of a detached external condyle in an adult, where the rest of the joint was normal, has given good results in several cases, but should be combined with a transplantation of the ulnar nerve at the same time, because there is usually already present a cubitus valgus deformity which may increase after the operation. Removal of the condyle should never be performed in children or in adults without careful consideration of what the future effect on the joint would be. It has the advantage of simplicity and is useful in certain cases, but in most instances a reconstruction operation for the purpose of preserving and reuniting the condyle is the rational procedure. When the external condyle is detached in childhood it continues to grow and, if contact is maintained with the head of the radius, a good articulation is developed. In such cases the stability of the joint may depend in a large measure upon the external condyle, and it must be preserved. This can be done and the valgus deformity partially corrected by freshening the old fractured surfaces on the condyle and the humerus and restoring the fragment to as nearly its normal position as possible. It is held in position by an autogenous bone nail, or other type of internal fixation, and union is assisted by an osteoperiosteal graft laid along the posterior lateral side. If the fragment cannot be brought down sufficiently to correct the valgus deformity, it can be united at the most advantageous position and an osteotomy done above the internal condyle to restore the alignment of the joint. Several operations of the type described were done with excellent functional results.

Arthroplasty is indicated as a reconstructive measure when there is serious impairment of motion, or where there is so much distortion or damage to the joint as a whole that it is reasonable to anticipate a per-

FIG. 8

Case 4. Late result in fracture of external condyle treated by closed reduction; non-union with deformity of joint. Such results are preventable by immediate open reduction.

sistence of pain or a recurrence of limited motion if other types of reconstruction work are done. Arthroplasties are contraindicated in children or in cases where the detached fragment extends so high on the humerus that sufficient breadth of surface to secure a stable joint cannot be preserved in remodeling the lower end of the humerus. The results from arthroplasty in properly selected cases are most gratifying.

TRANSPLANTATION OF THE ULNAR NERVE FOR DELAYED ULNAR NEURITIS

Delayed ulnar neuritis, or palsy, is a rather frequent complication following the fractures of the humeral condyles occurring in twelve cases of this series. It is usually associated with a cubitus valgus deformity, the increased angle causing a stretching and gradual traumatism of the nerve when the elbow is flexed. It may also be associated with fractures of the internal condyle or internal epicondyle, a fact not generally recognized, but clearly demonstrated by several very interesting cases in this group. Reports of similar cases have recently been made by Copeland.

In one case, a fracture of the internal epicondyle with non-union, the ulnar nerve was unduly lax and slipped over the displaced epicondyle with a snap when the elbow was flexed. In another, a fracture of the

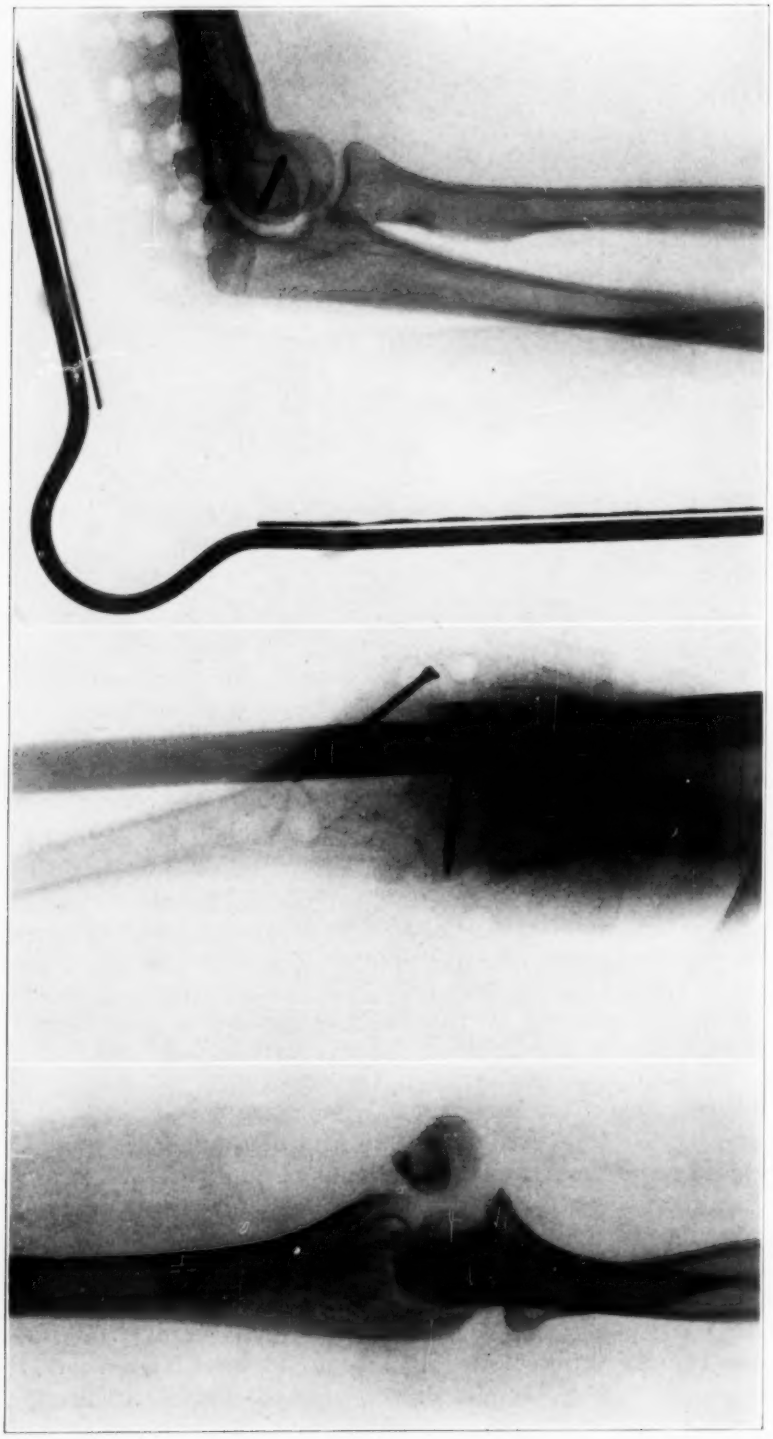

FIG. 9

Case 5. Fracture of the internal condyle with displacement and rotation of fragments. Internal fixation with wire nail.

FIG. 10

Case 5. Six years after operation, showing solid union. Normal function.

internal condyle, the space between the olecranon and internal epicondyle was narrowed and the nerve pinched when the elbow was extended. A third case was due to partial incorporation of the ulnar nerve in callus formation. The symptoms in another case started twenty-five years after a fracture of the internal condyle. At operation the size and course of the ulnar groove were found to be normal, but the nerve was fixed in the groove by adhesions to its sheath which prevented the normal glide of the nerve when the elbow was flexed. This was sufficient to produce a typical neuritis.

In all cases where symptoms were present the usual anterior transplantation was done. In several cases with a cubitus deformity not corrected by the reconstruction operation, transplantation was performed as a preventive measure.

COMPLETE FRACTURES OF THE CONDYLES WITH DISPLACEMENT TREATED BY DELAYED OPEN REDUCTION

Contrary to original expectations, the results in this group have been somewhat disappointing. It was hoped that accurate reposition of the displaced condyle, even as long as several months after the fracture, would be followed by firm union without serious epiphyseal disturbance. Haas and others have reported some most interesting results from their experimental work in transplantation of the epiphyses in growing animals. Practically without exception, when a portion of a joint containing an epiphyseal area was completely detached and transplanted to a similar

location in the opposite leg, although bony union occurred, arrest of epiphyseal growth resulted.

On the other hand, roentgenographic studies of the epiphyses in condylar fractures, treated by the closed method, showed continued growth for years, even in those condyles with complete non-union. The condyle did not grow to its normal size or shape, but it was thought that this might be due largely to decreased functional demands. With these facts in mind, it was felt that union in good position, with increased functional demands secured by a careful, delayed, open reduction, would minimize or prevent epiphyseal disturbance. Certain technical difficulties were encountered at operation which probably account in a large measure for the disappointing results.

In order to expose and mobilize the detached fragment sufficiently to derotate it, or to manoeuver it back to its original position, practically all of the soft tissue attachments had to be severed. In some cases the fragment was unavoidably detached completely. Efforts to avoid disturbance of the blood supply by decreased exposure and mobilization resulted in poor reduction and insecure fixation, which were equally bad. Epiphyseal disturbance was to be expected in those condyles completely detached at operation, but it was disappointing to observe similar changes when a relatively large amount of the muscular attachment was preserved.

Delayed open reductions were done in six cases, in three of which the fragment was completely detached. A study of the results showed that firm bony union in good anatomical position was achieved in all cases where sufficient exposure was obtained and a wire nail used for internal fixation. When insufficiently exposed, or fixed by some type of suture, union occurred with some displacement. In all cases subsequent roentgenograms taken two to four years after operation showed definite distortion of epiphyseal growth, consisting of decreased and irregular growth of the condyle, premature ossification of the epiphysis with varying degrees of varus or valgus deformity. Limitation of motion persisted for long periods of time; in some cases an appreciable amount was permanent.

ACUTE FRACTURES OF THE CONDYLES TREATED BY IMMEDIATE OPEN REDUCTION

There were twelve cases in this group and, while not all were without complications, the results as a whole were by far the best. The operation is relatively simple, as the detached condyle is freely movable and with a little manoeuvering can be fitted back accurately into its original position without dividing any of the muscular attachments. When possible the nail is not driven through the epiphyseal line, but we do not hesitate to do so when necessary. The detached fragment was always found to be much larger and to have carried with it much more of the articular surface than the roentgenographic appearance led one to anticipate. This was due to the fact that a large portion of the condyle was composed of cartilage which did not show in the roentgenogram. In many instances the

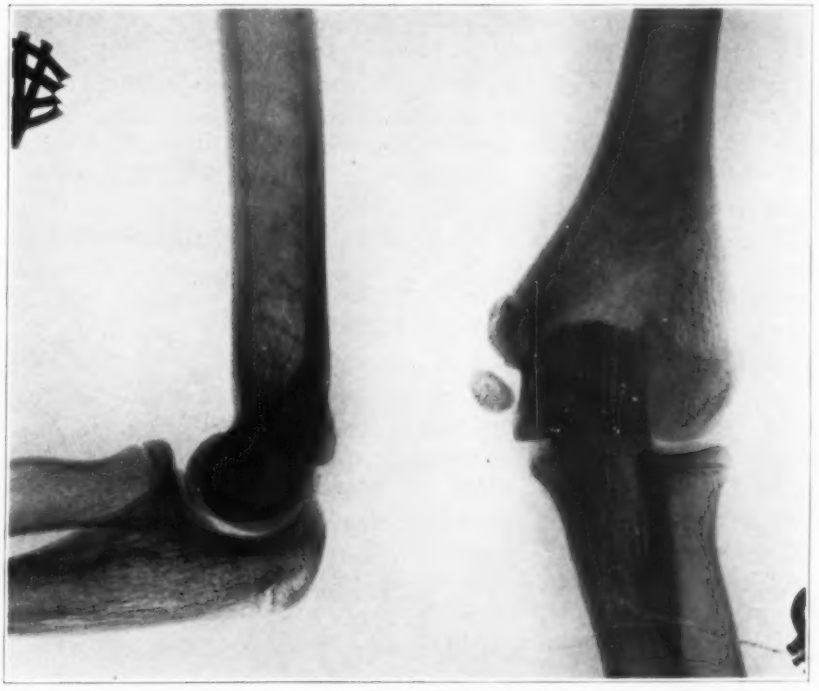

FIG. 11

Case 6. Avulsion of the internal epicondyle five years after treatment by closed reduction. Non-union, with delayed ulnar neuritis.

fragment was completely rotated or turned end over end by the pull of the attached muscle. The futility of attempts at closed reduction was clearly demonstrable in these cases.

Various types of internal fixation—including catgut, steel wire, and nails—were tried. The only one found to be reliable was the nail, which was easy to insert, gave firm dependable fixation, and closely approximated the fractured surface. The head of the nail is left slightly protruding so that it can easily be palpated under the skin and removed after three weeks with a local anaesthetic.

In six of the cases in which the nail was used, excellent functional and anatomical results were obtained. In four cases we have been able to secure roentgenograms from two to six years after the reduction, and they have not shown any retardation or distortion in the growth of the condyle or other evidence of epiphyseal disturbance. Two other patients appeared normal during the period of roentgenographic observation—four and six months—and subsequent reports from their parents state that the arm in each case is normal in appearance and use. One patient at the end of four months shows probable epiphyseal changes and two others are too recent to report.

While it is not contended that occasional excellent results may not

be obtained by closed reduction in displaced condylar fractures, it is claimed that the method is at best uncertain as regards both the original reduction and the subsequent maintenance of position. In view of the serious disturbance in the future function of the elbow joint, resulting from failure at closed reduction or from delayed open reduction, it is felt that, when confronted with the decision as to the method of treatment in an acute condylar fracture, we are not justified in taking such chances. An immediate open reduction should be advised in all cases where there is any appreciable displacement of the fragment.

AVULSION OF THE INTERNAL EPICONDYLE

Avulsion of the internal epicondyle is in reality an epiphyseal separation. It is included in this study because it is so closely associated with condylar fractures and because the factors connected with its treatment are so similar. Attached to the internal epicondyle is the strong tendinous origin of the flexor group of muscles. The epiphyseal line between the epicondyle and the internal condyle does not close until about the sixteenth year. When strong lateral strain is put upon the elbow the internal epicondyle may be avulsed either separately or associated with a fracture of the internal condyle. Here again the strong pull of the attached muscles prevents reduction or retention of the fragment by closed reduction. In order to obtain union and prevent arrest of growth of the epicondyle the separated epiphyseal surfaces must be kept in close coaptation and held until union occurs.

There were ten acute cases and six old separations studied. Of the acute cases only four were treated by open reduction, and these were the only ones that united properly. The other six were cases of either nonunion or malunion. In three of the acute cases the detached epicondyle was drawn into the elbow joint, locking its motion and requiring open reduction.

Complications were frequent with the unreduced cases. Limitation of extension was frequently seen. This is caused by a blocking of the olecranon which fits in closely against the internal epicondyle when the elbow is extended. Pain after use and bony tenderness about the epicondyle persist in some cases indefinitely. Delayed ulnar neuritis necessitated transplantation of the ulnar nerve in several instances. When limitation of motion, pain, or delayed ulnar neuritis produced disability, the detached or malunited epicondyle and any excess new bone formation were removed, the ulnar nerve usually being transplanted at the same time.

SUMMARY

A review of the data brought out in the study of this series of condylar fractures warrants the following conclusions:

1. Serious disability and disturbance of function in the elbow following fractures of the condyles of the humerus in children is much more frequent than is appreciated by the average surgeon treating fractures.

2. Closed reductions are at best uncertain and are frequently impossible when there is displacement of the fragment.

3. Accurate reduction and the maintenance of close apposition of the fractured surfaces are necessary to prevent non-union or malunion, with subsequent epiphyseal disturbances resulting in deformity and impairment of function.

4. Delayed open reductions restore the position of the fragments and achieve bony union, but are almost uniformly followed by epiphyseal disturbance, producing permanent impairment of function.

5. Immediate open reduction, using some type of dependable internal fixation, preferably a wire nail, is the treatment of choice and will give the highest percentage of satisfactory results.

BLOCK OSTEOTOMY OF THE FEMUR *

BY EDWIN W. RYERSON, M.D., CHICAGO, ILLINOIS

Abnormal curvature of the femur, due to fracture, rickets, or other causes, usually requires operation for its correction. A transverse osteotomy, while easy to perform, is decidedly not easy in its after-care. The maintenance of proper alignment and apposition requires constant attention and considerable surgical ability. Cuneiform osteotomy, the removal of a wedge of bone, affords greater stability, but a distinct loss of length. A curved osteotomy is mechanically preferable, but is difficult to perform with accuracy.

If, however, a rhomboidal section of the femur can be removed, with its longer side toward the convexity of the curve, and then be transposed by rotating it 180 degrees around its axis, the curvature will not only be corrected, but an actual lengthening of the femur will also be produced. This operation has not received much attention by American surgeons, and the technique of securing the bone block in position has not been standardized. The only article on the subject which the writer has been able to find in recent American literature was published by S. Orell, of Styrsö, Sweden (*The Journal of Bone and Joint Surgery*, XIV, 643, July 1932), under the title of "Osteoplastic Cuneiform Osteotomy in the Treatment of Ankylosis". This name, originated by Orell, is rather cumbersome, although it is descriptive. As a substitute, the writer advocates the term "Block Osteotomy". Orell appends a bibliography of thirty-four references, most of which, on examination, deal with other forms of osteotomy. His paper is based upon the report of two cases, where a block osteotomy was performed in 1930,—one in the tibia and one in the femur. In both cases a narrow wedge of bone was removed, boiled for ten minutes in normal salt solution, reversed in position, and secured by catgut sutures. The results were excellent.

The operation is of such great value, in its rather limited field, that it seems worth while to describe again what is apparently a useful method of securing stability and alignment.

CASE REPORT

In 1922 the author examined a girl nineteen years of age who, in early life, had suffered four fractures of the right femur, resulting in very considerable outward bowing. The left femur had been broken twice, but was comparatively straight, and was about one and one-half inches longer than the right femur. The last fracture had occurred in 1916, when the patient was thirteen years old. Dr. Gibney had operated on the right femur when she was eight. No details of the operation were available.

The patient was short and plump, and, while not distinctly of the Fröhlich type, was considered to have had some endocrine disturbance resulting in osteogenesis imperfecta, or fragilitas ossium.

* Read before the American Orthopaedic Association at Washington, D. C., May 10, 1933.

FIG. 1

Bowed femur, due to fractures in shaft. Note also old fracture through neck.

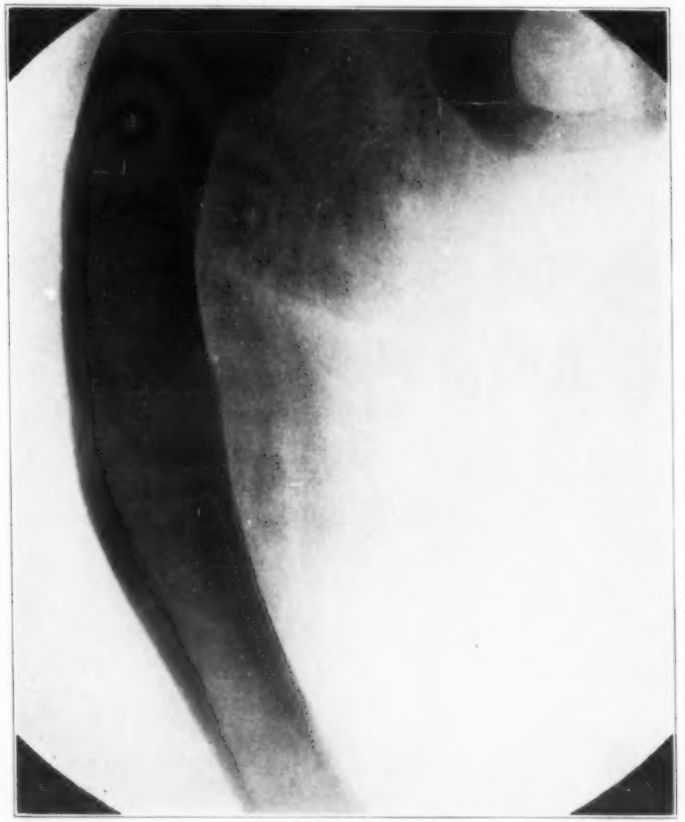

FIG. 2

Showing two healed fractures in shaft. Note density and thickness of cortex.

FIG. 3

Three months after operation. Beginning union. Position improved.

FIG. 4

Four months after operation. Solid union. Partial absorption and fracture of beef-bone peg.

FIG. 5

Six months after operation. Good union. Good correction.

The bowing and shortening of the right femur were sufficiently deforming to warrant an attempt to improve the condition; therefore, on September 6, 1922, the following operation was performed:

The shaft of the femur was exposed just above the middle. It was much flattened in section, and was apparently not covered by periosteum. A thick wedge of bone, rhomboidal in outline, was sawed out by two cuts of a Gigli saw. The outer side of the wedge was about one and one-eighth inches in height, and the inner side eleven-sixteenths of an inch. The measurements had been determined beforehand by cutting out a tracing of the x-ray film. This wedge of bone was lifted out and examined. The medullary cavity was much flattened anteroposteriorly, corresponding to the shape of the cortex, and the marrow content was unusually hard. There was very little bleeding from either end of the canal. The wedge was now replaced into the femur, but in reversed position, so that the long side faced medially and the short side faced laterally, thus materially straightening the bowing, and adding considerably to the length of the bone. A beef-bone peg, five inches long and five-sixteenths of an inch in diameter, was inserted into the medullary cavity to hold the wedge-shaped block in position. It was found that the wedge projected too far medially to make an absolutely perfect apposition. This was probably due to the length of the peg, although it was not realized at the time.

The position, however, seemed fairly satisfactory, and the stability was unexpectedly good. After suturing and dressing the wound, a Thomas splint was applied with traction, and the limb was suspended in a Balkan frame. Union was rather slow, but was complete in four months. The correction of the deformity was highly satisfactory, and the only untoward result of the operation was a partial paralysis of the peroneal nerve. This paralysis remained for a considerable time, and only disappeared after a neurolysis performed by Dr. Ober, at which operation no actual lesion of the nerve was discovered.

The x-ray films, taken after the block osteotomy, are interesting because they show an apparent death of the bone-block, followed by a complete regeneration through a process of creeping substitution. The gradual absorption of the beef-bone peg is well shown, and was more rapid in this case than in many others which have been observed.

It will be noted in the x-ray films that the block was cut at a greater angle than was necessary to make a sufficiently satisfactory correction of the bowing. In consequence of this, the cut surfaces were not in perfect apposition. It is probable that union would have occurred in a shorter time if the bones had been in closer contact.

No particular discussion is needed of Orell's proposal to boil the bone-block in normal salt solution. He did this in his first case because the fragment had accidentally become contaminated while being handled. A possible hint as to the reason for boiling the fragment in his second case is his statement that a preliminary preparation of the bone graft for the purpose of removing as completely as possible connective tissue and fat from the bony canals would probably hasten and render more complete the union and reconstruction of the graft.

The author's belief is that many of the bone cells in a bone-graft do not die, and that even a few living bone cells in a graft may be of very great value. Therefore, it does not seem wise to boil a fresh and uncontaminated bone-graft, or to do any more "tinkering" with it than is absolutely necessary.

THE ASSOCIATION OF PULMONARY AND OTHER TUBERCULOUS LESIONS IN CASES OF PROVEN BONE AND JOINT TUBERCULOSIS

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The variance in the statistics of percentage of cases of bone and joint tuberculosis having coincidental parenchymal lesions may be accounted for by the fact that most of these figures have been taken from cases diagnosed clinically but not proved by laboratory examination. There is also no doubt that many of the so called cures of tuberculous lesions have occurred in cases that were never tuberculous.[5] In seeking to determine what percentage of our cases had lung involvement, we therefore considered only those cases that were proven.

During the past year, 164 consecutive patients clinically diagnosed as tuberculous were observed on the Orthopaedic Service of the University Hospital. One hundred of these were found to have positive pathological reports, or specimens (aspirated material, cultures taken at operation, or smears from sinus tracts) were positive on direct smear, potato-egg culture, or guinea-pig inoculation. Fourteen negative guinea-pig or pathological reports were returned. In fifty cases there were no pathological or bacteriological reports because of the location of the lesion, the severity of the disease, or failure to secure specimen. Other concomitant tuberculous lesions have also been noted, together with the age of onset of the disease. In forty-four cases the tuberculin skin reaction is indicated.

Twenty-seven patients in our series had definite clinical and roentgenographic evidence of parenchymal lesions or adult pulmonary tuberculosis, and thirteen had active childhood tuberculosis. Of forty-one children, aged one to fifteen years inclusive, eight, or 19.5 per cent., had parenchymal lesions and ten were reported to be of the childhood type. The total number having lung involvement in the children's group was 44 per cent. In the fifty-nine patients, sixteen years or over, parenchymal lesions were found in nineteen, or 32 per cent., and childhood tuberculosis in three, giving a total of 37 per cent. Of thirty-seven cases in adults alone, there were fifteen, or 40.5 per cent., who had pulmonary lesions.

If, according to Hecker [3], we figure the percentage according to the age onset, we find that in sixty cases, or 42 per cent, the onset was before the age of sixteen, with twelve patients having the adult type of tuberculosis and thirteen the childhood type. Of forty patients with the onset after sixteen years, there were sixteen, or 40 per cent., who had parenchymal lesions.

In eight per cent. of our cases the patients were found to have renal

tuberculosis; 6 per cent., tuberculous epididymitis; and 5 per cent., tuberculous tonsils; only 14 per cent. had single tuberculous lesions. Forty-two of forty-four tuberculin skin tests were reported positive.

HISTORY

The association of other tuberculous lesions with bone and joint tuberculosis has long been recognized, the bone lesion being always secondary. Wiseman and his contemporaries, in the latter part of the seventeenth century, sometimes included under "King's Evil" diseased conditions which were not tuberculous; yet, says Little [1]: "They had evidently a distinct idea of what was meant by the strumous or scrofulous diathesis and associated pulmonary consumption, chronic joint disease, enlarged glands and caries of the vertebrae with one another". Again, in the nineteenth century, we find the French physician, Pierre Louis (1787–1872), giving us the statement since known as Louis' law that "Tuberculosis of any part is attended by tuberculosis in the lungs".

Statistics have been presented from time to time to show how frequently this pulmonary involvement occurs, but most of these cases have been diagnosed only clinically. The figures of Armand-Delille [2], of 2 per cent. in infants and 5 to 6 per cent. in adults having Potts' disease, vary from those of Hecker [3], of 63.6 per cent. in children one to three years of age and 5.26 per cent. in patients over sixteen years of age having active lung and skeletal tuberculosis. Hecker states that the percentage will be higher in those in whom the onset occurs earlier in life. MacKinnon [4] in 1924 showed that two-thirds of his patients over sixteen years of age with bone and joint tuberculosis had pulmonary involvement.

In Lehman's [9] series of cases of tuberculosis of bone and joints, in which over 80 per cent. occurred in children under fourteen years of age, 28.2 per cent. of those having Pott's disease had active concomitant tuberculosis elsewhere. Fifty per cent. of the cases of hip joint tuberculosis and 66.66 per cent. of tuberculosis of the knee had other tuberculous lesions.

Keller [10] found only four cases of pulmonary involvement (8.7 per cent.) in forty-six cases of tuberculous osteo-arthritis. Ragolsky [10] in his series of 200 cases of surgical tuberculosis found that one out of six, or 17.5 per cent., had bona fide pulmonary tuberculosis.

"The clinical diagnosis of bone tuberculosis is still to be made with much caution and still to be regarded with suspicion and is to be accepted as an undisputable fact only when it has been checked by pathological section and the demonstration of the tubercle bacilli." [5] Of 822 cases in the files listed as tuberculosis, Milgram says that only 139, or 17 per cent., were proven cases; fifty-four, or 38.8 per cent., were not correctly diagnosed until operation and pathological section gave the diagnosis. Hough [6] reports on the tuberculin skin reaction in a group of seventy-seven clinical cases of bone and joint tuberculosis in which only fifteen, or 19.5 per cent., were proven cases.

Smith [7], writing on monarticular arthritis, informs us that this lesion

TABLE I

SUMMARY OF CASES *†

NAME	AGE	SEX	RACE	AGE AT ONSET	TUBERCULIN SKIN TEST**	ADULT PARENCHYMAL TUBERCULOSIS	CHILDHOOD TUBERCULOSIS	TUBERCULOUS LESION	OTHER TUBERCULOUS LESIONS
F.S.	12	F	Col.	5	P	–		Left hip, right knee	
E.Y.	12	F	W	11	P	–		Left hip, ilium with sinus	
A.J.	44	M	W	38	O	–		Greater trochanter with abscess Left wrist with tuberculous bursa (died)	
I.H.	27	M	W	26	O	–		Left radius with sinus	
C.B.	19	M	W	18	P	–		Sacro-iliac joint with sinus	
A.S.	4	F	W	3	P		P	Spine { Tonsils and adenoids Cervical lymph nodes	
H.D.	14	F	Col.	10	O	–		Right hip	
H.L.	3	M	W	2	P	–		Left knee	
S.W.	26	F	W	23	O	–		Right elbow	Adenitis
D.M.	17	F	W	17	O	P		Right first metatarsal, left ankle	
P.A.	17	M	W	15	O		P	Right knee	Tonsils and adenoids
W.W.	15	M	W	15	O		P	Right hip	
K.R.	5	M	W	3	P		P	Left hip with abscess	
C.Z.	24	M	W	24	O	–		Left ilium	Multiple sinuses, thigh
E.O.	20	M	W	19	O	–		Right femur with sinus	
S.C.	2	M	W	2	P	P		Right knee	
T.S.	16	F	W	14	P	–		Right knee, manubrium sterni	3 to 7 ribs anterior
W.McC.	48	M	W	46	O	–		Spine (died)	Epididymitis. Transverse myelitis. Meningitis
I.B.	14	F	Col.	13	O	–		Right knee with sinus	
R.R.	28	M	Col.	27	P	–		Spine with psoas abscess	
C.L.	18	M	W	3	O	–		Spine	Renal, vas and epididymis
M.P.	12	M	Ind.	6	P	–		Right hip, cervical spine	
P.M.	45	M	W	43	O	P		Spine	Left epididymis
V.O.	5	M	W	5	P		P	Right ischium, cold abscess	
C.M.	25	M	W	22	O	P		Left elbow, right hip	Bilateral renal
H.K.	26	M	W	25	O	P		Spine and sacrum, abscess	
E.L.	32	F	W	32	–	–		Spine with psoas abscess	
N.J.	8	F	W	4	O	P		Left tarsus	
R.B.	31	M	W	20	O	–		Spine	Left renal
W.R.	28	M	W	24	–	–		Spine with sinus	Cervical glands
L.K.	37	M	W	35	O	P		Left acromioclavicular joint with abscess	
R.L.	8	M	W	6	O		P	Right ankle	
L.J.	25	M	W	17	O	–		Spine with sinus	
A.C.	19	F	W	6	P	–		Tenosynovitis	
P.M.	7	M	W	4	P	–	P	Spine	Tenosynovitis
N.T.	61	M	W	59	O	P		Spine, right elbow with sinus	
F.G.	26	M	W	24	O	P		Hip, greater trochanter right	
K.H.	22	M	W	13	O	–		Hip with sinus	
J.K.	2	M	W	1½	P	–	P	Right hip	
M.M.	34	F	W	28	O	P		Spine	Bilateral renal, healed laryngeal
V.L.	23	F	W	21	P	P		Right sacro-iliac	Right renal, peritoneal sinus right thumb (metacarpal-phalangeal joint)
E.H.	27	F	W	26	P	P		Right sacro-iliac	
M.D.	25	F	W	3	O	P		Spine, right hip	
S.W.	6	F	Ind.	5	P	–		Hip with sinus, and ilium	
S.K.	11	M	W	7	P		–	Left hip with sinus	
E.K.	25	F	W	17	O	–		Dorsal spine	Left renal and ureter (Fluid aspirated from chest at age of 13)
G.L.	50	M	Col.	49	O	–		Dorsal spine with cold abscess, tuberculous 11–12 ribs	Pleurisy with effusion
J.P.	53	M	W	52	O	–		Left elbow, sinus	
I.B.	16	F	W	3	P	–		Right hip	
B.L.	10	F	W	9	O	–		Spine with abscess	
R.G.	25	F	W	21	O	P		Sacro-iliac joint with sinus	
L.B.	18	F	W	5	P	–		Right hip with abscess, subastragaloid joint	
B.B.	7	F	W	2	P			Left knee with sinus	
J.M.	4	M	W	1½	P	P		Left hip with sinus	

TABLE I (*Continued*)

SUMMARY OF CASES *†

NAME	AGE	SEX	RACE	AGE AT ONSET	TUBERCULIN SKIN TEST**	ADULT PARENCHYMAL TUBERCULOSIS	CHILDHOOD TUBERCULOSIS	TUBERCULOUS LESION	OTHER TUBERCULOUS LESIONS
E.D.	17	F	W	9	O	–	P	Spine with sinuses (died)	At autopsy, mediastinal lymph nodes, nephritis, cystitis, chronic meningitis, localized pulmonary tuberculosis.
J.S.	8	M	W	4	O	–		Spine with sinuses	
O.S.	4	M	W	2	P	–	P	Spine, left ankle	Scrofuloderma, cervical adenitis
E.K.	29	F	W	10	P	–		Sinus, left hip	
T.Z.	20	M	W	17	P	–		Right hip with sinus	
P.P.	21	M	Ind.	18	P	P		Spine with abscess	
M.C.	34	F	W	22	P	P		Spine with abscess	
M.B.	50	M	W	50	O	–		Elbow with sinus	
J.P.	10	M	W	8	O	–		Left knee	
M.C.	12	F	W	10	O	–		Right elbow	
M.K.	17	F	W	15	P	P		Left hip	
A.W.	11	F	W	2	O	–		Spine	Tonsils
S.G.	24	M	Col.	23	O	–		Left elbow	
P.B.	16	M	W	14	O	–		Left ankle, sinus	
E.W.	13	F	W	13	P		P	Right ankle	
E.C.	18	F	W	3	O	–		Right hip	Left kidney
M.S.	11	F	W	11	O	P		Right hip with sinus (died)	Meningitis
E.P.	14	F	W	12	P	–		Right hip	
E.G.	26	M	W	21	O	–		Right hip with sinus	
E.G.	31	M	W	29	P	–		Right hip	
H.S.	10	M	W	10	P		P	Right elbow	
W.T.	17	M	W	16	O	–		Subastragaloid joint with sinus	
E.S.	13	M	W	12	O	P		Right knee	
S.J.	38	M	Col.	35	O	–		Spine with abscess	
P.Z.	45	M	W	43	P	P		Wrist, right (died)	Laryngitis, bilateral renal epididymis
H.S.	20	M	W	15	O	P		Left hip	
W.B.J.	18	M	Ind.	11	P	–		Left forefoot	
J.C.	16	M	W	15	O	–		Right knee	
M.M.	14	F	W	12	P	P		Both ankles, first metatarsal-phalangeal joint left	
D.R.	4	F	W	3	P	–		Left hip, abscess	
P.B.	18	F	W	3	P	–		Spine with sinus	
R.G.	12	M	W	3	O	–		Bilateral hip, abscess	Cervical adenitis with sinus
A.M.	3	F	W	1½	P	–		Right subastragaloid joint	
E.S.	29	F	W	27	O	P		Left shoulder, left elbow	
E.S.	13	M	W	12	P	P		Left knee	Tonsils
L.R.	15	M	W	7	O	–		Humerus with sinus	Tonsils
J.R.	16	M	W	6	O	–		Right hip	Anal fistula, adenoids
S.S.	15	F	W	7	P	–		Right hip with sinus	
L.C.	8	F	W	4	O	P		Bilateral wrists, right mid-tarsal joint	
W.W.	26	M	W	16	O	–		Left hip and ankle	Epididymitis, anal fistula, prostatitis
A.K.	11	F	W	5	O	–		Left hip	
E.R.	25	M	W	22	P	P		Spine, right elbow (died)	Left epididymis
W.T.	8	M	W	3	O	–		Left knee	Skin (lupus vulgaris)
A.K.	19	F	W	10	O	–	P	Right knee	Cervical glands
E.S.	10	M	W	7	P	–		Right hip	
R.K.	31	M	W	20	O	–		Right shoulder with sinus	

* Analysis of Above 100 Cases by Race and Sex:

	Male	*Female*	*Total*
White	52	37	89
Colored	4	3	7
Indian	3	1	4
Total	59	41	100

** P = test positive
– = test negative
O = test not done

† There were four deaths in this series.

may simulate tuberculosis very closely. "It is impossible to differentiate these lesions from those of tuberculosis by physical examination or the x-ray." The majority of these patients will recover without further treatment.

Following this trend of thought, and bearing in mind King's [8] statement, *viz.*: "In order that proper therapeutic measures can be initiated with hope of success and also to properly evaluate benefit derived from treatment, we consider it essential to establish beyond a doubt the nature of the pathological process", we prepared our report based on the study of 100 cases of substantiated bone and joint tuberculosis.

RENAL INVOLVEMENT

Harris [11] says, "In a series of 100 patients whom I have examined for this purpose, more than half, on adequate examination, displayed multiple foci of haematogenous origin. . . . But with the arrival of the day when tuberculosis is clearly regarded as a systemic disease will come the time when examination of the urinary tract will be thought as necessary as the examination of the chest." In another contribution [12] he states: "Tuberculosis of the spine and other forms of bone tuberculosis arise by invasion of the bone from the blood stream. . . . In the majority of cases this will be a pulmonary lesion with its concomitant mediastinal adenitis. . . . Renal tuberculosis is particularly prone to accompany bone lesions." In his series of 100 patients having bone and joint tuberculosis, 37 per cent. of the adults had tubercle bacilli in the urine constantly or intermittently, and 13 per cent. of the children had similar positive reactions over a period of one and one-half to five years.

In our series it was definitely established that 8 per cent. had renal tuberculosis, four of the cases having bilateral involvement. However, in view of Harris' work and because we have found renal tuberculosis relatively late in our cases, we believe that more frequent and more careful urinalyses should be made, together with guinea-pig inoculation, in cases of true skeletal tuberculosis. As a matter of routine, we take roentgenograms of the chest of every patient having bone and joint tuberculosis, and make a special stain and guinea-pig inoculation of the urine of those patients having an acid urine, containing no organisms but in which white blood cells and some red blood cells are found by ordinary staining methods.

TUBERCULIN SKIN TESTS

In forty-four of our cases the patients were tested by the human tuberculin and when possible the tests were done by the same physician, using the Mantoux method. The tuberculoprotein ultrafiltrate or tuberculoprotein trichloracetic gave the best results. Only two patients were reported as having negative reactions.

Later twenty-six patients with tuberculous bones and joints—fifteen of whom were proven cases—and two patients with old poliomyelitis,

aged fourteen and sixteen years, were tested by the Mantoux method. With T.P.T. (tuberculoprotein trichloracetic), one-tenth cubic centimeter of a one to ten thousand dilution was first used and three of the fifteen cases gave positive skin reactions. The one to one hundred dilution was then used and seven cases developed erythema and induration in forty-eight hours, while all were positive in seventy-two hours except the controls which were still negative.

Hough [6] found positive tuberculin skin tests, both bovine and human, in 60 per cent. of his orthopaedic cases of verified tuberculosis, and positive bovine but negative human tests in 33 per cent. Harris [12], however, states: "The great majority of the cases are of human origin". If we are justified in the assumption that the skin reaction is specific for the type of organism, then we can assume that, at least in our forty-four cases, the majority are of human origin.

TUBERCULOUS CONTACT

We believe with Forbes [13] that intimate and prolonged family contact is responsible for massive infection and the production of childhood tuberculosis; 68.4 per cent. of the patients in his series gave a history of family contact with the disease. We were unable to confirm this but, of our twenty-seven cases of parenchymal tuberculosis, the history of contact was as follows: twelve, not known; thirteen, positive; and only two, negative.

SUMMARY

Attention is again called to the fact that bone and joint tuberculosis is a systemic disease.

The point is stressed that a positive diagnosis is essential to correct treatment and accurate interpretation of results.

Of 164 consecutive patients, seen during the past year, clinically diagnosed as having bone and joint tuberculosis, 100 were established cases, fifty had no pathological or bacteriological reports, and in fourteen the guinea-pig inoculation and pathological results were negative.

Pulmonary lesions in substantiated bone and joint tuberculosis average 40 per cent. in our series,—27 per cent. with adult pulmonary or parenchymal lesions, and 13 per cent. with active childhood pulmonary tuberculosis. Patients over sixteen years of age averaged 37.3 per cent.; those under sixteen years, 44 per cent.

When the pulmonary lesion is determined from the age of the patient at onset of the bone and joint lesion, those under sixteen years—sixty patients—averaged 42 per cent. and those over sixteen years—forty patients—averaged 40 per cent.

Eight per cent. of our cases had renal tuberculosis.

More frequent urinalyses, guinea-pig inoculation, and special search for tubercle bacilli are urged in the treatment of patients having an acid urine containing no organisms, but in which white and red blood cells are found by the usual staining methods.

A negative tuberculin skin test, especially if negative to repeated increasing dosage of a recently prepared or fresh solution of old tuberculin or tuberculoprotein trichloracetic, is of definite diagnostic value.

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A TREATMENT FOR FRACTURE OF THE NECK OF THE FEMUR*

BY GUY W. LEADBETTER, M.D., WASHINGTON, D. C.

Fractures of the neck of the femur have become a vital issue to the surgeon, the patient, and the relatives of the latter. During the last few years the standard of demand by the laity for better functional results of fractures has been more exacting. It is incumbent upon the physician to select the method which, in his judgment, will cause the least amount of primary shock during manipulation, to utilize the fixation which will adequately maintain reduction, and, finally, to secure a high percentage of anatomical reduction and firm union with good physiological results.

Whatever method of reduction and fixation is selected, the writer believes that the so called after-care is the most important in the preservation of life. Because of age, the functions of the individual are at a basic level and, in most cases, trauma and subsequent shock have caused the vitality to drop to a still lower level. It is essential, therefore, that no treatment be instituted which will further depress the vital centers, for pain in most fractured hips subsequent to reduction is negligible. Good elimination and frequent change of position are important factors. Due attention to the two dangerous complications—general toxicosis, having its origin in the intestinal tract, and pulmonary hypostasis—will also aid in preventing the third serious complication,—that of mental bewilderment, delirium, or psychosis.

Without hesitation the writer recommends plaster fixation, properly applied, as the best means of carrying out all the above mentioned treatment. Plaster fixation must have two objectives: first, to immobilize the fracture; and, second, to facilitate postoperative care. This plaster should be applied tightly and we have found the following technique to be the best.

With the hip reduced and in the proper degree of abduction and internal rotation, a one-layer thickness of glazed cotton is placed about the torso from the nipple line over the affected hip to a point about half-way between the hip and the knee. Then a long strip of felt, one-half an inch thick, is placed about the pelvis, extending from just above the iliac crests to the trochanters, and completely encircling the pelvis. This is all the padding necessary and allows very tight application of plaster. The body portion is first applied as tightly as possible, snug coaptation being the aim. Firm pressure over the injured hip is necessary. Below the hip no padding is applied. Two plaster slabs molded carefully to the contour of the leg, one posteriorly and one anteriorly, are bandaged closely to the skin. No padding is placed beneath the heel, as this is molded well and the plaster coapted tightly. If necessary, one may apply

* Read before the American Orthopaedic Association at Toronto, Canada, June 16, 1932.

FIG. 1

First manoeuver. Hip flexed to ninety degrees.

a roll of plaster about the two molded splints to insure a little better fixation. The cast is then trimmed around the perineum and the pelvis in the usual manner. The "U" is cut from the body section of the cast, leaving about a six-inch band across the lower abdomen and over the symphysis. The sides must be well supported to prevent the patient from swinging the torso, thereby diminishing the amount of abduction of the injured leg.

This method gives firm and comfortable immobilization and allows the treatment previously described to be instituted without danger of changing the position of the reduced fracture. It permits relatively free movement of the thoracic cage, makes a semireclining position possible, and facilitates transportation from bed to chair. In our series of cases, using this type of application, we have had no decubital ulcers. In one or two instances, in which the individual was fairly vigorous, we have been able to allow walking with the aid of crutches after the fourth week.

The procedure for manipulation should be non-shocking and one which accomplishes anatomical reduction of the fractured fragments with the greatest degree of accuracy. Anatomical reposition of the fragments is the only position which insures good union and good function. Up to the present time the Whitman method is the widely accepted one. Dr. Whitman's article written in 1904 clearly shows the genius of his logic. Abduction and internal rotation quite apparently are the only positions for reducing a

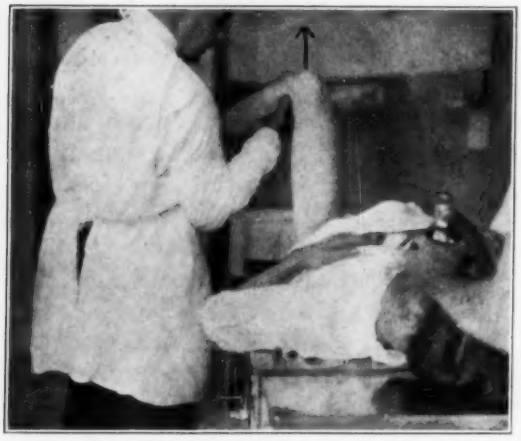

FIG. 2

Second manoeuver. With knee flexed, traction is made in longitudinal axis of femur as indicated by arrow.

traumatic coxa vara. The objections to his manipulation are:

1. It is very often a shocking procedure in the hands of the average practitioner, as well as in some skilled hands, and is done too empirically.
2. It does not consider all the anatomical and physiological factors present in the hip joint, such as muscular attachment and muscular tension.
3. The extreme degree of abduction called for, often overreduces the fragments and produces no reduction, with poor continuity.
4. The forced internal rotation called for serves only to relax the Y ligament at the hip joint and many times results in no reduction and gives no splinting effect whatsoever.
5. There is no definite test or examination other than the roentgen ray, which definitely tells the manipulator that the fracture has been reduced.

FIG. 3

Third manoeuver. Leg is circumducted into measured degree of abduction and internal rotation.

To the postoperative care and to the plaster-fixation method the writer can well subscribe.

Treatment by the various traction methods, or by the so called sand-bag method—which is no method at all—is not to be considered.

FIG. 4

Fourth manoeuver. Heel-palm test. With leg in abduction and internal rotation, the heel is allowed to rest in outstretched palm. With complete reduction this position should be maintained without force. If leg rotates externally, reduction is not complete.

The manipulation suggested here is simple, anatomically sound, nonshocking, and offers opportunity for 100 per cent. reduction. The patient is first anaesthetized, usually with ethylene gas, on the fracture table. The uninjured leg is harnessed to the foot stirrup.

The injured leg is then flexed at the hip at ninety degrees, with the lower leg at ninety degrees to the thigh. Direct manual traction in the axis of the flexed thigh is then made, together with slight adduction of the femoral shaft. In this position the thigh is internally rotated approximately forty-five degrees. The leg is slowly circumducted into abduction, the internally rotated position being maintained. The amount of abduction varies with the individual and can be measured accurately, representing the difference in degrees of the angle made by the fractured neck with the shaft and the angle between the neck and the shaft on the normal side, as evidenced by the roentgenogram.

The test which in our experience has indicated that the fracture has been completely reduced is as follows. After the leg has been brought down in the measured degree of abduction and internal rotation, the heel of the injured leg is allowed to rest on the outstretched palm. If the reduction is complete, the leg will not evert itself. Should there be no interlocking of the fragments, however, the leg will slowly rotate externally. This has been found to be an invariable test. In all instances where the test evidenced internal rotation, the reduction was anatomically complete. In cases where the internal rotation had to be forced, the reduction was never complete, as proven by stereoscopic roentgenograms, the only criterion for a good reduction. The observation is made that as

FIG. 5

Case 1. Patient aged seventy-eight. Premanipulative roentgenogram. Note slight degree of coxa vara with considerable external rotation.

the leg is circumducted into a position of abduction and internal rotation without tension, the position of the leg tends to assume the proper degree of abduction and internal rotation. If abducted too far, one will feel the definite tension of the adductors which can be neutralized by allowing the leg to assume a smaller angle of abduction. If internal rotation is too great, the leg, under the heel-palm test, will rotate outward until the proper degree of internal rotation is reached. One can approximate the desired degree of such abduction and rotation by a study of premanipulative roentgenograms, for, at the time of the actual manipulation, the finer degrees will be adjusted automatically by muscle tension of the hip.

The consideration of the embryology and anatomy of the hip joint lays the foundation of the manipulation described. In the embryo, the hip joint is in the quadrupedal position,—namely, it is flexed and only after several weeks of extra-uterine life does the flexed position tend to assume that which is necessary for bipedal ambulation. This change of position accounts for the rotation in the neck of the femur, also for that of the fibers constituting the capsular ligament. It is a physical fact that when the hip is brought back to the quadrupedal position, all structures about the hip joint are relaxed, since the base of the neck of the femur is the

FIG. 6

Case 1. After reduction. Note slight degree of abduction and complete internal rotation.

FIG. 7
Case 1. End result. Bony union.

insertion point of the hip joint muscles; this forms the center of rotation which relaxes these structures in manipulation. One cannot depend upon an extreme grade of abduction or upon the tenseness of the Y ligament, as suggested by Dr. Whitman, since it is not true that these ligamentous fibers are taut in internal rotation. One must depend upon an accurate interlocking of the fragments.

The type of fracture must also be considered, for in fractures of the neck of the femur one sees not only transverse fractures, but also spiral, oblique, and comminuted fractures. It is, therefore, just as difficult to maintain the position in a spiral, or comminuted, fracture of the neck of the femur as in any other bone. The fixation must be equally complete. The transverse type of fracture, as a rule, gives little difficulty in maintenance of position. In general the oblique, or spiral, fracture must be abducted slightly more than the transverse type after reduction. An extreme grade of accuracy in completing the apposition of the fragments is the factor on which rests the possibility of union, for, with the absence of periosteum, the presence of synovial fluid, and the activity of the

FIG. 8

Case 2. Patient aged sixty-seven. Premanipulative roentgenogram. Coxa vara marked. This case demands more abduction than Case 1.

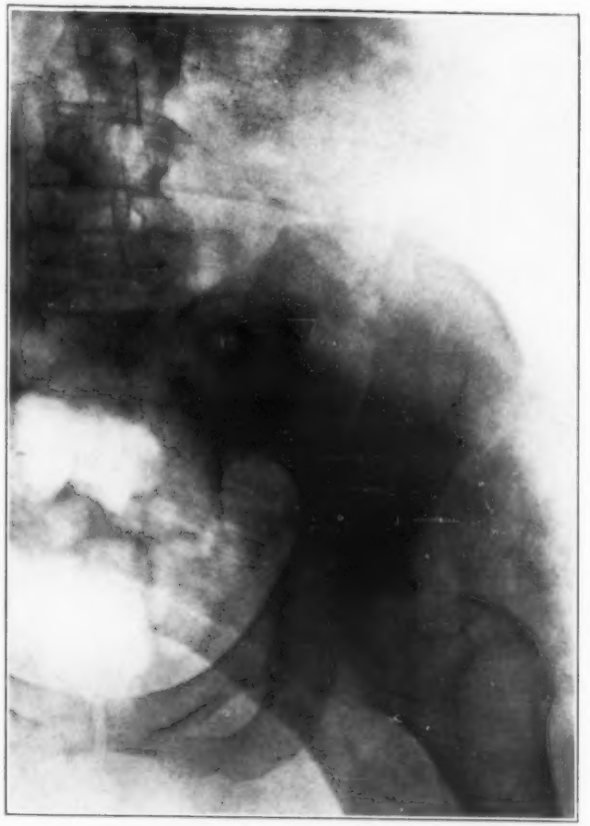

FIG. 9

Case 2. After reduction. Note greater abduction than in Case 1.

FIG. 10

Case 2. End result. Bony union with coxa vara. Good function.

cancellous structure of the neck as the only real source of bone formation, it can readily be seen that, if this cancellous tissue is encroached upon or blocked by an inaccurate reduction, by improper fixation, or by the use of internal metal fixatives, proper bony healing can never take place. Circulation is important only in so far as it is allowed to course through its normal channels which supply nourishment to both ends of the fractured fragments. In reconstruction operations for non-union, the author has been much impressed with the very rapid and strong bridging over of the fractured surface of the head and of the neck in cases in which imperfect apposition had been made. This shows in itself that healing properties are present in the necks of most femora, and that all that is demanded is proper, careful reduction with thorough fixation for a period of not more than ten to twelve weeks.

In this paper is presented a study of thirty-six cases, all treated by the method just described. The five cases of intertrochanteric fracture obtained bony union. The thirty-one cases of intracapsular fracture reported here (Table I) have been checked and rechecked and represent accurate findings. These patients have been interviewed or heard from through their personal physicians. Of these thirty-one cases, a total of twenty-two, or 70.9 per cent., obtained bony union and nine, or 29 per

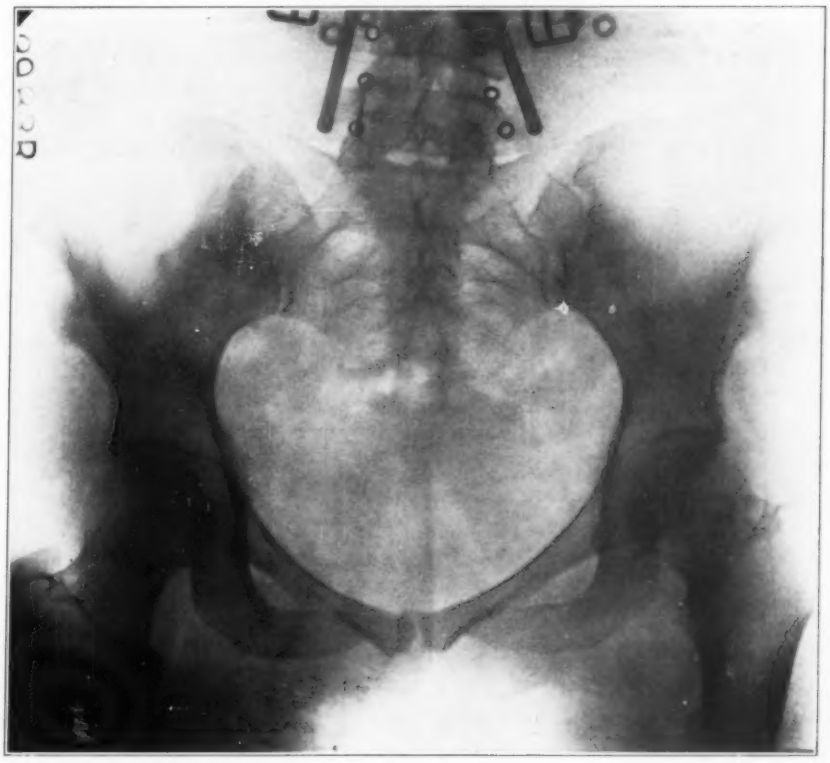

FIG. 11

Case 3. End result. Bony union.

cent., presented fibrous union and are considered in this series as non-union cases. Of the non-union group two, or 6.4 per cent., showed absorption within a period of approximately six weeks. The remaining seven, or

TABLE I

INTRACAPSULAR FRACTURES OF THE NECK OF THE FEMUR

Age	Cases	Union	Non-Union		Fair Function	Good Function	Deaths
			Fibrous	Absorption			
30–40	1	1				1	
40–50	3	3				3	
50–60	2	2				2	2
60–70	14	10	4		4	10	
70–80	6	4	1	1	1	4	1
80–90	5	2	2	1	2	2	1
Total	31	22	7	2	7	22	4

22.5 per cent., obtained fair function. Of the cases showing fracture of the anatomical neck, in which union was obtained, ten, or 32.2 per cent., were patients over sixty years of age, and four, or 12.8 per cent., were over seventy years of age. The remainder were in the decades between forty and sixty years. All of these cases united well. The deaths numbered four, or 12.8 per cent. The first was due to embolism at the tenth week and the second was due to diabetic coma at the twelfth week. Both of these cases belonged in that group in which absorption occurred. The third died of cellulitis of the neck at the twentieth week, and the fourth of acute nephritis at the fourteenth week. With the exception of the first and last named cases, fracture of the neck of the femur was not implicated in the cause of mortality.

This paper, then, presents a method of manipulation which is anatomically and physiologically logical. It is easy to accomplish and, by applying the test which the author believes to be infallible, assures one of good anatomical reduction, thereby greatly enhancing the chances of bony union by preserving the normal relations of the only source of callus in the neck of the femur,—namely, the cancellous structure. As soon as we free ourselves from the didactic and empirical teachings which have been in vogue for the last twenty-five years and apply ourselves to the anatomical and physiological problems presented in fractures of the neck of the femur, and arrive at agreement on better methods of complete fixation of these fractures, then, and only then, will the percentage of good end results increase.

THE SIGNIFICANCE OF BLOOD CHEMISTRY TO ORTHOPAEDIC SURGERY *

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The topic under discussion, involving as it does the relationship of humoral pathology to orthopaedic surgery, is so broad that its superficial consideration only will be attempted. A few years ago the author would have said that few points of contact existed between the metabolist and the orthopaedic surgeon. The bone setter of a former age was certainly not concerned with the chemical developments of the medical sciences, and his lineal descendant, or should we say his lineal ascendent, the orthopaedic surgeon, had so much to do with physical stresses and strains and the mechanical devices for relieving deformities as to find little time for the more abstract concepts of metabolism. At present, however, it is clear that the enterprises of metabolist and orthopaedic surgeon overlap at a number of points, and orthopaedic surgery would be far behind the march of modern therapeutic measures were it to fail to concern itself with subjects in the domain of metabolism, such, for example, as nutrition and growth.

The skeleton is not, as it seems to the medical student when he pursues his first dissections in anatomy, "as dry as bones". Likewise the various skeletal structures, although presenting numerous mechanical problems comparable to those of engineering, are by no means static, and thus differ fundamentally from the steel girders and other structural materials with which the engineer has to do. Bone is alive indeed, and like other living matter is in constant flux. The continuous wear and tear is compensated under normal conditions by a steady supply of calcium, phosphorus, protein-building stones, and other elements for the reconstitution of disintegrating skeletal structures. It is perfectly correct to speak of metabolism of bone, and it is self evident that the deformities presented to the modern orthopaedic surgeon—not excluding those due to trauma, tumors, or infection—are influenced by the nutrition of the bone. The successful union of fracture is obviously affected by humoral conditions, and a large variety of substances carried in the blood are known to be necessary for the health of bone.

Among the humoral factors entering into the metabolism of bone, calcium and phosphorus, vitamin D, the parathyroid hormone, and the growth hormone of the anterior lobe of the pituitary gland are outstanding. Information regarding other factors is still limited. We are very much alive to the significance of calcium, phosphorus, and vitamin D in the prevention of rickets and osteomalacia. It is probable that we are not as

* Read before the American Orthopaedic Association, Washington, D. C., May 10, 1933.

alert as we should be in suspecting humoral deficiencies in osteoporosis. Vitamin C may play a part, and it is not improbable that relative deficiencies of various kinds are responsible for much of what we call senility, including the osteoporosis of senility. We have acquired some definite information on the subject of the parathyroid glands in metabolism of bone. An oversupply of parathyroid hormone produces the multiple fibrocystic disease known as generalized fibrous osteitis, or better, as parathyroid osteosis. We have excellent grounds for attributing to the eosinophilic cells of the anterior lobe of the pituitary gland a major rôle in the stimulation of the osteoblastic cells of bone. Acromegalia and gigantism, associated with eosinophilic pituitary tumors, are evidence of this. But suggestions have not been offered for the pathogenesis of many other abnormalities of bone. Fragilitas ossium (osteogenesis imperfecta), defined by Lobstein in 1833, is possibly the expression of a metabolic disorder. Individuals affected with this disease tend to be short and slender, and the basic defect is said to be inability to form osteoblasts. These are few in number and anomalous in structure, and apparently represent failure of certain primitive cells to differentiate as they should. Although suitable evidence is not at hand, one might suspect in this disease either a deficiency of the growth hormone or a deficiency of one of the vitamins.

Chemical analysis of the blood is a poor guide to the interpretation of any of these skeletal abnormalities. Methods for the detection of the hormones and vitamins in blood are not as yet available, and, although changes of the mineral constituents are noted in certain diseases of bone, these are inconstant and afford less reliable diagnostic criteria than some observers have supposed. Calcium is unequally distributed between the plasma and the corpuscles. Only traces are found in the latter and consequently the results of analysis must be expressed either for plasma or for serum,—usually for serum. The normal figure by the Kramer-Tisdall method, as modified by Clark and Collip, is from nine to eleven milligrams in each 100 cubic centimeters of serum. In the cerebrospinal fluid, and in ultrafiltrates of serum, the figure is only from four to six milligrams in each 100 cubic centimeters, which indicates that almost half of the calcium in the blood is bound to protein and therefore is not diffusible. The diffusible fraction is ionized to something more than fifty per cent. It appears that the question of calcium ionization has been given more emphasis than is justifiable, since the non-diffusible and diffusible fractions are in chemical equilibrium.

In postoperative tetany and other conditions of parathyroid deficiency, including rickets associated with tetany, the calcium falls to five or six milligrams in each 100 cubic centimeters of serum. With overfunction of the parathyroid glands high figures are obtained, but not constantly. In cases of parathyroid tumor, associated with the typical picture of parathyroid overfunction, the figure is usually high—sometimes even twice as high as normal—but in other cases, even when the calcium balance is negative, the values are normal. On the other hand, high calcium figures

may be obtained in a variety of diseases of bone for which there is no good evidence of parathyroid overfunction, and consequently hypercalcaemia is not diagnostic of parathyroid osteosis as has been supposed. Apparently any generalized or extensive destruction of bone may cause an increase in serum calcium, and high values are thus obtained at times in multiple myeloma and in extensive metastatic carcinoma.

The inorganic phosphorus in the blood is so equally divided between corpuscles and plasma as to permit using whole blood in its determination. However, if the corpuscles are allowed to lake, their organic phosphate esters are liberated, and in the plasma these are rapidly hydrolyzed, releasing additional phosphorus as inorganic phosphate ions. Under normal conditions, the values for inorganic phosphorus are from two and five-tenths to four milligrams in each 100 cubic centimeters of serum among adults, and as high as five milligrams in each 100 cubic centimeters of serum among young children, whose bones grow rapidly. High figures are obtained in tetany and low figures are obtained in parathyroid osteosis. A reciprocal relationship between calcium and phosphorus is often apparent in these diseases, so that feeding phosphates in cases of threatened tetany may depress the serum calcium and precipitate tetany. This is a matter of very practical significance.

The determination of the phosphatase activity of the blood serum adds information of some diagnostic significance in skeletal disease. Phosphatase is an enzyme which hydrolyzes phosphoric esters. It is widely distributed in the tissues and occurs abundantly in gastric mucosa, kidney, and the growing bone of youth. The distribution in bone is irregular; the enzyme is found particularly in the zone of provisional calcification and in the periosteum.

The method of Kay [4, 5] for estimating the phosphatase activity of blood serum has found use with modifications by others.[2] The principle of the method is to incubate a substrate of sodium betaglycerophosphate in the presence of a satisfactory buffer to maintain a constant hydrogen-ion concentration. The extra phosphate formed by the hydrolysis of the glycerophosphate is a measure of the enzymatic activity of the serum. High figures are obtained for phosphatase in a variety of the skeletal diseases, including parathyroid osteosis, multiple myeloma, generalized carcinomatosis, rickets, osteomalacia, and Paget's disease. In focal osteitis fibrosa, in the cystic disease of bones of youth, and in non-skeletal disease, the phosphatase activity of the blood is not at all affected or only slightly affected.

Robinson's opinion of the rôle of phosphatase in the deposition of calcium phosphate in growing bones is that the osteoblasts and hypertrophic cartilage cells secrete the enzyme, and this, by hydrolyzing the phosphoric esters of the blood, brings about a local increase in the concentration of phosphate ions. The solubility product of the tertiary calcium phosphate in the blood is thereby exceeded and deposition of this salt occurs in the ossifying zone. The finding of an increased amount of phosphatase en-

zyme in the circulating blood, in generalized destructive diseases of bone, suggests its increased production, possibly in an attempt at compensation. The large amounts in the mucosa of the stomach and in the kidneys may in part account for the predilection of these organs for metastatic calcification.

It will be recalled that Shipley and his associates, in 1922, produced rickets in rats either by diminishing the phosphorus of the diet and supplying an optimal amount or an excess of calcium, or by reducing the calcium and maintaining the phosphorus of the diet. They concluded that a certain ratio of calcium to phosphorus is necessary to prevent rickets. The investigations of Howland and his coworkers, and those of Pappenheimer and others, confirmed this view and established the current opinion that the supply of calcium and phosphorus must not only be adequate but must be properly proportioned. There is good reason to believe that the advance of civilization has brought with it dietary habits which interfere with optimal conditions of nutrition in a variety of ways. Thus it is calculated that the diets of more primitive people contained not less than two grams of calcium daily, whereas the equivalent figure for the average American, not drinking milk, may frequently fall below the figure of forty-five-hundredths of a gram a day, which Sherman sets as an absolute minimum. Sherman and others urge the use of milk, or the addition of calcium salts to food, for human beings. This matter deserves special consideration in diseases of bone characterized by osteomalacia or osteoporosis, and in the healing of fractures. The large stores of calcium in the skeleton protect against acute manifestations of calcium deficiency, but the osteoporosis of old age, of hyperthyroidism, and of long standing chronic infections, and the not infrequent delay in the union of fractures imply that chronic deficiency of calcium is an important problem in public health.

What salt of calcium may be best for supplementing diets is a question recently receiving attention. It probably makes little difference provided a rich supply of vitamin D is added, but in most cases it seems best to provide phosphorus in suitable proportions together with the calcium, and for this purpose calcium phosphates are desirable. The calcium phosphates, however, are relatively insoluble, particularly in the alkaline medium of the intestine. The dibasic or secondary calcium phosphate has been recommended because of its being less insoluble than the tribasic or tertiary phosphate. The results of recent experiments of Higgins and Sheard seem to upset this view. The tribasic calcium phosphate proved far more satisfactory than the secondary calcium phosphate in the nutrition of young chicks which were deprived of vitamin D.

Another borderland of orthopaedic surgery is the treatment of diabetic gangrene, and questions on this subject remain unanswered. Gangrene, we are all agreed, is intimately related to the atherosclerosis with which it is frequently associated, but whether the diabetes causes the atherosclerosis, as Joslin teaches, or atherosclerosis comes first with dia-

betes as a sequela is not established. The evidence, the author believes, favors the latter view and makes atherosclerosis the horse and diabetes the cart.

The slow healing of wounds after amputation of an extremity of a diabetic patient is due partly to diabetes, if this is not treated, and partly to the diminished supply of blood resulting from atherosclerosis. Bennett reported observations on the healing of wounds of dogs made diabetic by pancreatectomy. The pancreas was removed under ether anaesthesia. The animals were supported by a suitable regimen and injections of insulin until they had recovered completely; then insulin was withheld and when the diabetic state was fully developed fresh abdominal incisions were made under local anaesthesia. As compared to the behavior of identical wounds of healthy animals, the healing of these wounds was abnormal. The tissues were oedematous, deposit of fibrin was delayed, and its amount was restricted. The cellular reaction was excessive and the exuded cells appeared to be toxic. New blood vessels were slow to form and more thrombosis than normal was noted in preformed vessels.

Trimble and Carey have shown that the true sugar content of muscles is slightly increased and that of the skin, in cases of diabetes, is increased as much as threefold or more over the normal; they assume that this is a factor of considerable importance in the altered healing of wounds of diabetic subjects. The values for fermentable sugar of the muscles of the amputated extremities of diabetic patients were not found to be higher than normal.[6] The analyses appear in Table I. It is to be noted that the blood sugars were higher than normal, but not extremely high. The patients had been prepared for operation; their urines were sugar-free, but the attempt had not been made to reduce the blood sugar further than it would naturally fall with the control of glycosuria.

TABLE I

REDUCING VALUES OF ALCOHOL EXTRACTS OF MUSCLE FROM DIABETIC PATIENTS TREATED WITH INSULIN *

Case	Milligrams for Each 100 Grams			
	Before Fermentation	After Fermentation	Fermentable Sugar	Blood Sugar
1	99			225
2	58	26	32	
3	56	7	49	145

* General anaesthesia; tissue removed at operation; blood taken as near time of removal of tissue as possible.

Clinical experience has indicated that, when glycosuria is arrested, wounds of patients with diabetes heal as well as might be expected of wounds of normal subjects, even when the blood sugar is not entirely nor-

mal. The application of insulin locally or by injection subcutaneously near the wound is of little, if any, additional value. The essential factors are the control of glycosuria and the avoidance of acidosis and dehydration. In cases of diabetes with atherosclerosis, and in some without evidence of vascular abnormality, a higher than normal threshold for glucose often develops. In such cases, if treatment is intensive enough to force the blood sugar down to values considered normal in health (below 110 milligrams in each 100 cubic centimeters of blood), untoward symptoms are occasionally provoked. Intermittent claudication in these circumstances has been seen and symptoms suggesting angina pectoris have often been reported. It is not improbable that the tissues in cases of chronic diabetes require a higher than normal glycaemic level, which, if true, may mean that the healing of wounds will be less satisfactory when hyperglycaemia is combated too vigorously. The matter deserves further study. What is wanted is an investigation of the sugar content of the skin of patients with a high renal threshold, together with a study of the effects of hypoglycaemia, either relative or absolute, on the healing of wounds.

The author regrets his inability at this time to treat this subject more adequately. Significant matters such as the uric acid metabolism of gout, have been given no attention, but the few conditions to which he has alluded attest, he is sure, the significance of humoral pathology in orthopaedic surgery.

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HIP-FUSION OPERATION

BY FREMONT A. CHANDLER, M.D., CHICAGO, ILLINOIS

The operative fusion of many types of pathological hip joints is rapidly becoming the treatment of choice. This is especially true in cases of tuberculous infection. Intra-articular, extra-articular, and combined types of operations have been described and are widely used, the general trend being toward a more radical procedure which will obliterate the hip joint and permit an extensive area of fusion to develop. This may be accomplished by the following operation.

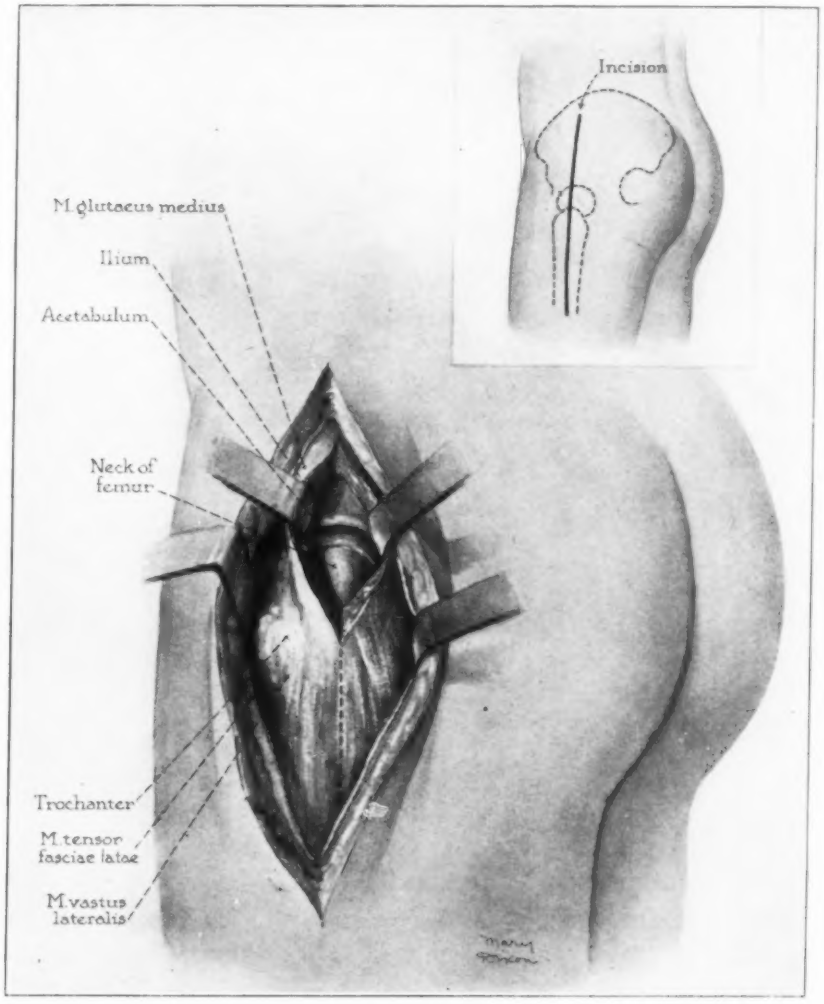

FIG. 1

Straight lateral incision exposing the greater trochanter, femoral neck, and superior margins of hip joint.

TECHNIQUE

The patient is placed on the well side at an angle of about forty-five degrees. A long vertical incision (Fig. 1) is made over the lateral aspect of the hip, extending from the crest of the ilium directly over the greater

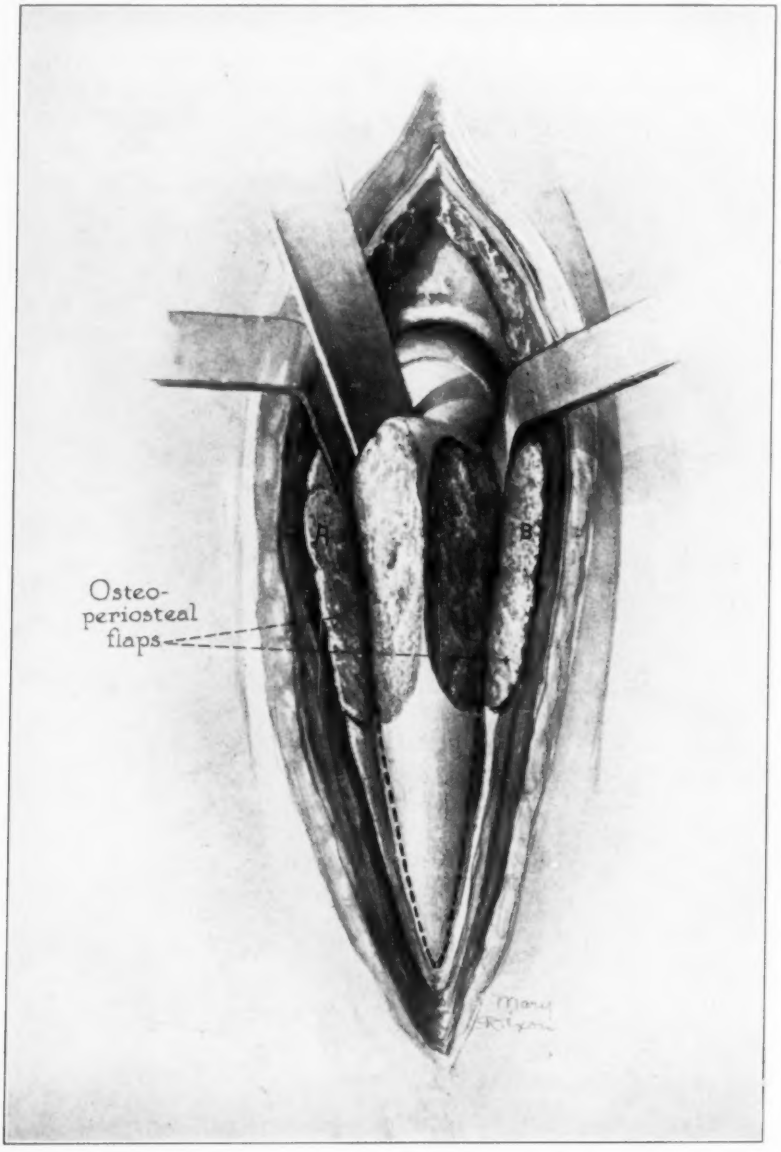

FIG. 2

Heavy grafts (*A* and *B*) of cancellous bone are reflected from the anterolateral and posterolateral aspects of the greater trochanter. The periosteal and muscular attachments of these grafts are not disturbed. A massive graft including the greater trochanter, lateral surface of the neck, and a portion of the cortex of the shaft is removed by converging cuts.

trochanter to the juncture of the upper and middle thirds of the thigh. The incision is carried through the subcutaneous tissue and splits the tensor fasciae latae, exposing the lateral aspect of the greater trochanter, the gluteus medius, and the origin of the vastus lateralis of the quadriceps femoris. The incision is then carried through the periosteum and origin

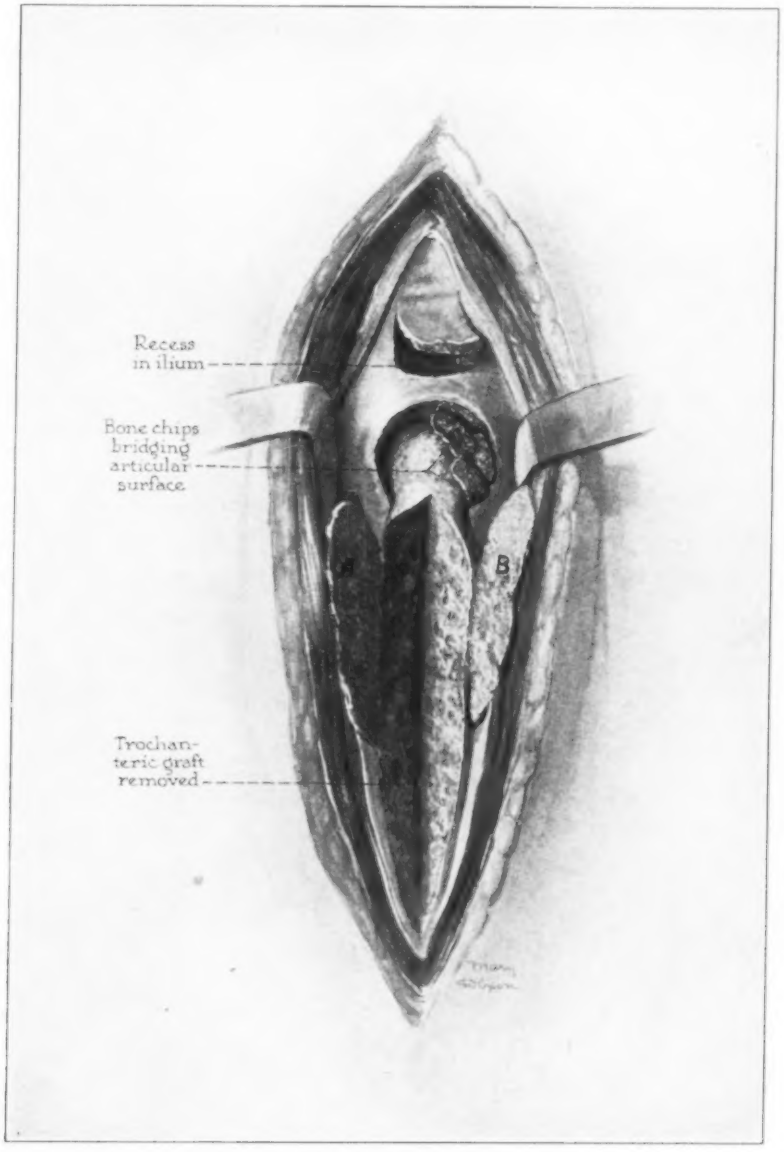

FIG. 3

Trochanteric graft removed. The cartilage of the head and acetabulum is removed and replaced by cancellous bone chips. A recess is made in the ilium above the margin of the acetabulum.

of the vastus lateralis and through the mid-portion of the gluteus medius, parallel to the muscle fibers. It is deepened to the superior aspect of the femoral neck and crosses the hip joint at right angles to the upper acetabular margin. Heavy bone flaps (Fig. 2, *A* and *B*) attached to the perios-

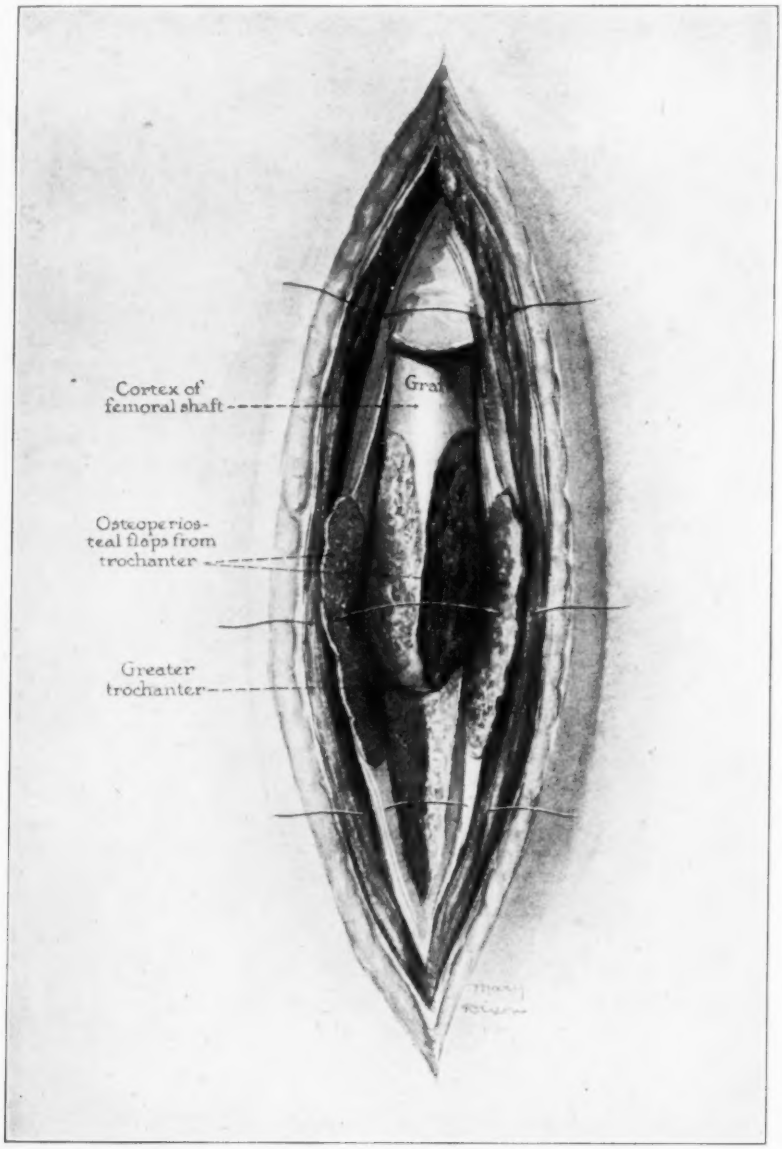

FIG. 4

The trochanteric graft is turned end for end and shaped for maximum contact. The cortical portion is then driven firmly into the recess on the lateral surface of the ilium. The thigh is abducted to establish firm contact with the graft. The osteoperiosteal grafts are firmly sutured over the free end of the massive trochanteric graft and the wound closed without drainage.

FIG. 5
Tuberculosis of right hip of five years' duration.

FIG. 6
Fusion at sixteen weeks after transplant of trochanter as described.

teum and muscle insertions are then elevated from the anterolateral and posterolateral aspects of the greater trochanter and the upper end of the shaft. These bone flaps should be generous in size and should extend well to the anterior and posterior portions of the base of the femoral neck. The capsule and periosteum of the femoral neck are then elevated anteriorly and posteriorly from the line of incision. These flaps are retracted anteriorly and posteriorly, exposing the trochanter. A massive graft, consisting of the main portion of the greater trochanter and the lateral cortex of the upper portion of the femoral shaft (Fig. 2), is removed by parallel cuts which converge in cross section through the cortex and cancellous tissue This graft extends from the mid-portion of the femoral neck to a point about five inches distal to the tip of the greater trochanter, and is about two-thirds the width of the upper end of the shaft. Its thickness is about one-half the diameter of the shaft.

Following the removal of this graft (including the greater trochanter), the upper lateral aspect of the femoral neck and head presents in the wound (Fig. 3). The capsule is stripped from the superior margins of the acetabulum. A curved arthroplasty chisel is then used to denude the surface of the femoral head and the opposing articular cartilage of the acetabulum. Fragments of cancellous bone taken from the graft bed are firmly pressed into this space. A hinged flap of bone is then elevated from the outer table of the ilium, just above the acetabular margin, and a recess made in the ilium to receive the cortical portion of the graft. The graft is then turned end for end and the cortical portion driven into the recess above the acetabulum. If the thigh is adducted during the fixation of the graft, better contact can be secured. On returning the thigh to a neutral position or to slight abduction, the trochanteric portion of the graft will make contact with the graft bed in the upper end of the femur (Fig. 4). With the graft in place, the hinged osteoperiosteal flaps removed from the trochanter are brought into position, covering the free end of the graft. The periosteum and origin of the vastus lateralis are sutured. The fascia, subcutaneous tissues, and skin are loosely sutured and a double spica cast applied to hold the thigh in the position of election until bony fusion is complete.

This operation combines features found in intra-articular and extra-articular types of fusion operations. The exposure of the graft and hip joint is obtained with a minimum of trauma. A massive graft, firmly fixed in the ilium and in wide contact with the neck of the femur, splints the joint and provides wide, bony contact for fusion.

THE RESULTS OF OPERATIVE FIXATION OF TUBERCULOUS SPINES

BY DON KING, M.D., ANN ARBOR, MICHIGAN

From the Department of Surgery, University of Michigan

This report is based on an inquiry into the present condition of ninety-three University Hospital patients who had spine-fusion operations for vertebral tuberculosis during the six-year period, July 1925 to July 1931. The operation was performed on those patients whose general condition was considered good and who showed no gross evidence of dissemination. Extravertebral osseous tuberculosis or draining sinuses outside the field of operation were not considered contra-indications.

The preoperative treatment was variable; in the majority of cases operation followed prolonged cast, brace, or Bradford-frame régime, in others operation was done after only a few days of frame care. The post-operative routine included Bradford-frame régime (average time eight months) with heliotherapy and high vitamin and high caloric diet. Before patients were allowed to become ambulatory, back braces were fitted which were worn for an average of about two and one-half years.

For this study we have been able to establish contact with eighty-four of the ninety-three patients. The majority of the results have been ascertained by check-up examinations in our own Clinic. In a few cases, however, this has been impossible and we have had to depend on questionnaires and examination by local physicians.

TABLE I

Total number of cases	93	
Total number of operations	96	
Males	49 or	52 per cent.
Females	44 or	48 per cent.
Result unknown	9	
Total number of cases in which end results are reported	84	

The time elapsing between operation and check-up is, for seventy-six of the eighty-four patients, between two and six and one-half years; for the remaining eight, between one and one-half and two years.

Types of Operation—Preoperative Complications

Of the ninety-three patients there were forty-nine males and forty-four females. The Hibbs type of plastic fusion operation was used sixty-two times. In twenty-four cases the Albee tibial-graft technique was employed, the graft being fused to the base of the spinous processes and laminae. For the remaining ten lesions, a type of Hibbs fusion, reenforced by ilial or tibial grafts, was used. There was a positive history of tuberculous contact in twenty cases. Thirty-nine of the patients had tuberculosis elsewhere. Nine patients showed definite evidence of transverse myelitis.

Classification of Results—Method Employed

1. Good result:

   A patient without subjective complaints or increase in deformity who has a solid fusion both from clinical and roentgenographic examination.

2. Fair result:

   A patient who has a moderate amount of pain or weakness, but is able to be up and about. The deformity is not increasing.

3. Poor result:

   a. A patient whose spine is so painful that he is not ambulatory.

   b. A patient whose deformity has increased since operation, although he may be asymptomatic.

   c. A patient whose death was directly attributable to the operation.

Using this method of classification, we find fifty-eight, or 69 per cent., of our eighty-four patients have a good result; two, or 2.3 per cent., have a fair result; and sixteen, or 19 per cent., have a poor result.* (See Table II.)

TABLE II

Results	Number		Per Cent.
Good	58		69.00
Fair	2		2.38
Poor	16	9 alive 7 dead from operation	19.00
Dead	8	no relation to operation	9.52
Total	84		99.90

Among the fifty-eight good results are two whose spines are in excellent condition but in whom the result should be somewhat qualified. The first is a man of thirty-seven years who developed postoperatively a severe polyarticular arthritis which has produced a bony ankylosis of both knees and one hip. The second is a boy of sixteen years who now has recurrent trophic ulceration of the sole of the foot because of a cord injury during operation. There are nine patients with poor results.

TABLE III

RESULTS LISTED BY DECADES

Age Period	No. of Patients	Good		Fair		Poor		Dead	
		No.	Per Cent.	No.	Per Cent.	No.	Per Cent.	No.	Per Cent.
1–10	18	13	72			3	17	2	11
10–20	20	15	75			2	10	3	15
20–30	22	14	63			3	14	5	23
30–40	13	11	84	1	8			1	8
Above 40	11	5	46	1	9	1	9	4	36
Total	84	58	69	2	2.3	9	10.7	15	18

* Figuring on a basis of seventy-six instead of eighty-four patients (omitting eight dead, no relation to operation) gives the following results: good, 76 per cent.; fair 3 per cent.; poor, 21 per cent.

To these we must add an additional seven whose deaths are directly attributable to the operation, giving a total of sixteen, or 19 per cent. Table III gives the ages of the patients by decades with the end results in each group. The highest percentage of good results was obtained in the thirteen patients of the fourth decade (84 per cent.). The mortality

TABLE IV

ANALYSIS OF DEATHS

1. Directly attributable to operation	7
Immediate, operative shock	2
Embolism (seven days postoperative)	1
Development or flaring up of other foci, directly attributable to operation:	
Meningitis	1
Sepsis in wound	1
Bilateral renal	1
Pulmonary	1
2. Dead of dissemination (no apparent relation to operation)	8
Tuberculosis	2
Meningitis	2
Kidney	1
Multiple foci	3
Total number of deaths	15

TABLE V

NEUROLOGICAL RESULTS IN PATIENTS SHOWING SPINAL-CORD COMPLICATIONS BEFORE OPERATION

Case	Symptoms	Duration	Onset	Outcome
1.	Marked spastic gait. Sensory level at umbilicus.	3–6 months	Gradual	Complete cure. Neurological examination negative.
2.	Incontinence, frequency, painful bladder. No spasticity.	3 months	Sudden	Complete cure.
3.	Unable to walk. Marked spasticity. No sensory paralysis.	4 months	Gradual	Good gait. Slight weakness left leg. Subjectively cured.
4.	Unable to walk. Marked spasticity. Sensory level at seventh dorsal.	1 week	Sudden	Good gait. Subjectively cured. Persistent Babinski.
5.	Unable to walk. Bladder and rectum sensory below umbilicus.	3 months	Sudden (3–5 days)	Complete subjective and objective cure.
6.	Weak legs 2½ years. Unable to walk 2 years. Bladder paralysis 2 years. Sensory changes.	2½ years	Gradual	Completely cured. Neurological examination negative.
7.	Spasticity, moderate. Sensory level at tenth dorsal.	2 years	Not given	Died of pulmonary tuberculosis soon after leaving hospital.
8.	Spasticity lower extremities occurred twice, second time with sensory changes.	Not given	Not given	Completely cured each time.
9.	Cervical Pott's disease. Diffuse spasticity of arms, legs; unable to walk or feed self. Sensory changes.	1 month	Sudden	Complete cure. Neurological examination negative.

in patients beyond the age of forty is high, 30 per cent. Among children the percentage of good results is around 75.

In addition to the three immediate postoperative deaths (two from shock, one from embolism), there are four which occurred soon after and seemed directly attributable to the operation. Eight others (Group 2, Table IV) show no apparent relation between operation and death.

Patients with Preoperative Neurological Complications (Table V)

One of this group of nine patients is dead. Eight are subjectively cured. On examination two of these have mild spastic weakness of the lower extremities. In six cases the paralysis had either partially or completely cleared while undergoing preoperative Bradford-frame régime, indicating little relationship between spine fusion and cure of the paralysis.

Factors Causing Further Deformity

Six patients in the poor-result class showed increase in the deformity following the fusion because of further vertebral body erosion (five children, one adult). All had a solid posterior ankylosis both by clinical and roentgenographic examination. In one case the kyphotic area was exposed (two years after fusion) and a very solid, satisfactory ankylosis was found.

In the unfused spine the most important factors in the prevention of further kyphosis are cessation of body erosion and adequate anterior vertebral-body contact. In the fused spine these factors are aided somewhat by the posterior bony bridge. Superincumbent weight produces considerable bending force at the apex of the kyphos through its proximal arm. Such a bending force continuously exerted on a living, plastic, posterior bony bridge will always cause bending or fracture with further angulation, if there is dead space to be filled anteriorly.

SUMMARY

1. Sixty-nine per cent. of eighty-four patients who have had fusion operations for tuberculosis have no complaints, have a solid posterior fusion, and show no increase of deformity.

2. Eighteen of these patients were, at the time of operation, from one to ten years of age. Seventy-two per cent. of this small group have an excellent result, indicating that for children the operation is safe and effectual.

3. Eighteen per cent. of these eighty-four patients are dead.

4. The stability of a kyphos is mainly dependent upon adequate anterior vertebral-body contact. Correction obtained by abduction of its jaws causes instability by producing a dead space in the diseased area. Posterior spine fusion does not restore sufficient stability to maintain correction obtained in this manner.

5. Eight of nine patients with preoperative neurological complications from cord pressure were subjectively cured. There is probably little relation between their operations and the disappearance of symptoms.

ACROMIOCLAVICULAR DISLOCATION: AUTOPLASTIC RECONSTRUCTION

BY CHESTER C. SCHNEIDER, M.D., MILWAUKEE, WISCONSIN

Complete dislocation of the acromioclavicular joint is a more disabling injury than is commonly believed and, unless surgically restored, is permanent in character. Untreated cases of complete dislocation result in an inefficient shoulder, more or less incapable of manual effort in the elevated position. The shoulder is weak, unstable, and difficult to control, these factors of disability being particularly evident to persons whose employment or diversion is of a vigorous nature.

AUTOPLASTIC RECONSTRUCTION

That the modern trend in reconstructive surgery is toward the employment of living autogenous tissues seems safe to presume. That the use of these substances will actually survive seems indicated by their increasing popularity as experience with them accumulates. In the reconstruction of the acromioclavicular joint the author prefers practically exclusively the use of fascia lata taken from the lower two-thirds of the thigh so as to include the iliotibial band. The fascial strip, eight inches long and three-quarters of an inch wide, tapered at each end, is re-

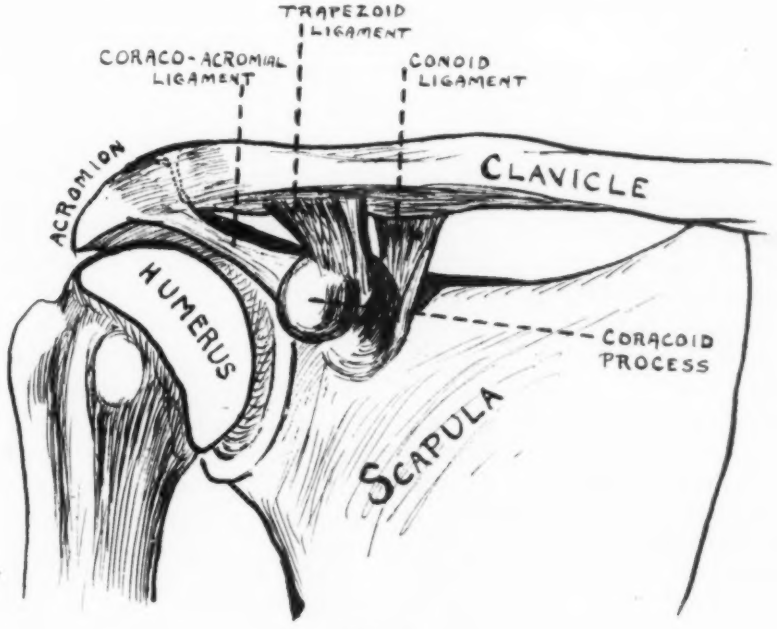

FIG. 1
Normal shoulder.

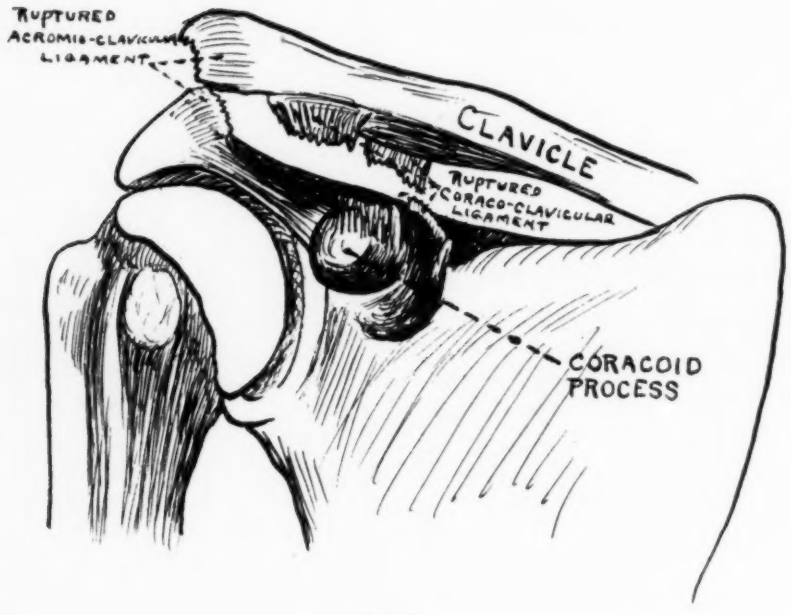

FIG. 2

Complete acromioclavicular dislocation.

moved and split longitudinally into a one-half-inch and a one-quarter-inch piece. These are placed in saline solution and the fascial sheath closed with a continuous No. 1 chromic catgut suture, followed by skin closure.

Approach to the acromioclavicular joint and coracoid process is made through a four-inch incision at the inferior outer margin of the clavicle, curved downward at the anterior margin of the deltoid. The acromioclavicular joint is exposed and the coracoid process identified. The superior acromioclavicular ligament is dissected off of the upper surface of the acromion from the articular surface lateralward about one-half an inch. Two three-sixteenths of an inch drill holes, equidistant (three-eighths of an inch) from the articular margin, are made in the acromion; also, two similar holes are drilled in the clavicle the same distance from the joint. The articular cartilage of the joint is left intact because Cadenat has shown that there is a limitation of forward projection of the arm and a slight decrease in the amplitude of the movements of abduction when the acromioclavicular joint is ankylosed.

Restoration of the inferior acromioclavicular ligament is accomplished with a mattress suture of the one-quarter-inch fascial loop, each end of which is carried downward through a clavicular drill hole, lateralward across the inferior surface of the joint, and up through its respective drill hole in the acromion. The ends of this loop are then crossed on the superior surface of the acromion and sutured to each other with twisted silk (Fig. 3). This procedure can be performed with facility by employing the suture threader devised by Gratz.

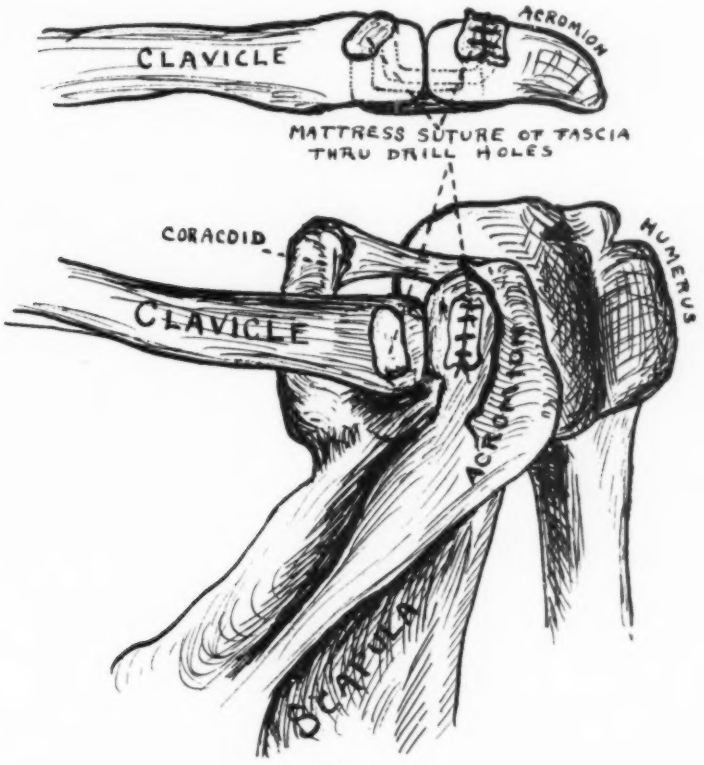

FIG. 3

Superior view of shoulder; first stage of reconstruction.

Next the coracoclavicular ligaments are reconstructed by carrying the one-half-inch fascial strip, threaded on a Gratz or a Gallie needle, under the inferior surface of the coracoid process and upward behind the clavicle subperiosteally at the site of insertion of the trapezoid, and crossed on the superior surface of the clavicle where the loop, under tension, is sutured with braided silk. The ends of this loop are drawn along the superior surface across the acromioclavicular joint and sutured together with silk to the acromial end of the acromioclavicular ligament, previously dissected up, thus restoring the ligament.

In this manner all the ligaments responsible for maintaining the integrity of the acromioclavicular joint have been rebuilt, and the clavicle is held firmly in position (Fig. 4).

The muscle and skin are closed in layers, the wound dressed, and a Dillehunt cast applied for immobilization. This cast (Fig. 5) is composed of arm, forearm, and torso segments applied separately and united to each other, while the involved shoulder is held as high as possible to relieve the strain on the repaired joint. The cast is removed in six weeks, followed by rehabilitation therapy. Full function should be recovered in three months.

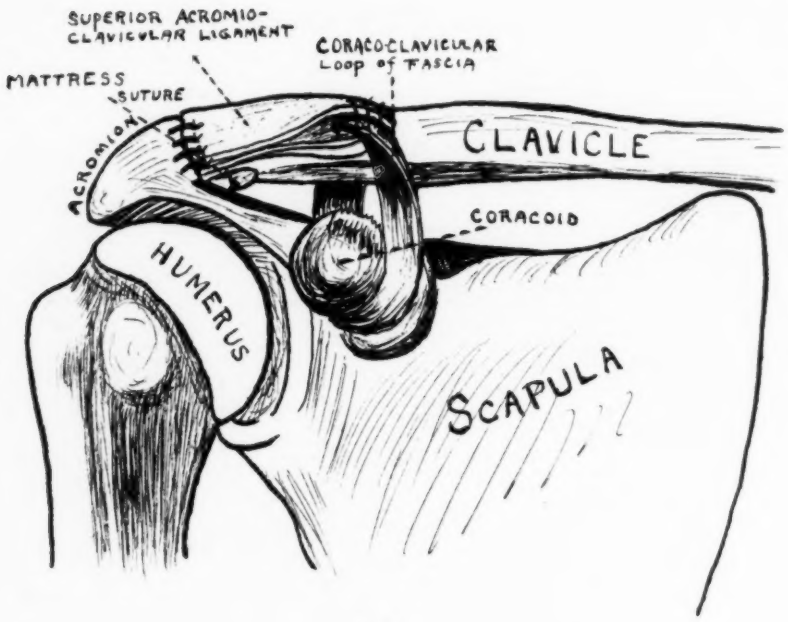

FIG. 4

Completed reconstruction of acromioclavicular joint.

The following two cases are cited to illustrate the type of individual upon whom the procedure has been employed successfully:

CASE 1. E. H., male, aged twenty-three, professional acrobat, sustained complete acromioclavicular dislocation while doing an acrobatic trick, November 21, 1927. Unable to continue his profession, he had been out of employment seven weeks when first seen by the author.

Physical examination revealed marked upward displacement of the outer end of the right clavicle, with excessive motion of clavicle on the acromion. There was marked pain at the acromioclavicular joint when vigorous motions of any kind were attempted.

An autoplastic reconstruction operation, according to the technique described, was performed on March 17, 1928. Patient left the hospital eight days after the operation and the wounds entirely healed in three weeks. Light exercises were commenced on May 7, 1928, and vigorous exercises were prescribed two weeks later. Before the expiration of three months, June 9, 1928, the patient was doing push-ups and hand-stands. All motions at the shoulder were perfect and the contour of the shoulder was normal. The patient subsequently returned to the stage in a slow-motion acrobatic act.

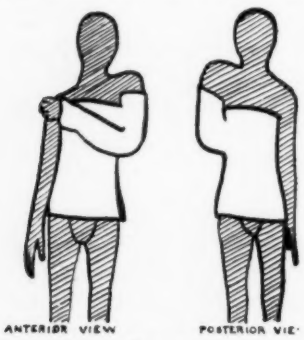

FIG. 5

Showing cast for acromioclavicular immobilization (Dillehunt).

CASE 2. C. W., male, aged thirty-six, professional rodeo rider, sustained a complete acromioclavicular dislocation on August 30, 1931, when he was thrown from a horse, landing on his left shoulder. The shoulder was at once completely disabled.

Physical examination revealed marked upward displacement of the distal end of the clavicle on the

acromion, with excessive mobility of the bones on each other. The entire shoulder was swollen and painful, and there was complete absence of voluntary motion.

An autoplastic reconstruction operation, according to the author's technique, was performed on September 2, 1931. The patient remained at the hospital until October 5, 1931. All dressings were removed on November 2, 1931. There was complete range of motion, normal contour, and excellent power (Figs. 6, 7, 8, and 9). The patient returned to his former vocation of rodeo rider.

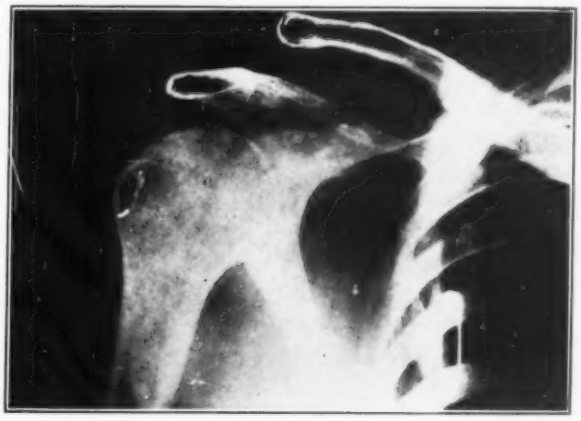

FIG. 6

Case 2. Roentgenogram before operation.

FIG. 7

Case 2. Roentgenogram after operation.

SUMMARY

1. An autoplastic reconstruction of the acromioclavicular joint for acute or chronic dislocation, using fascia lata and iliotibial band, is described.

2. Two cases of reconstruction of the acromioclavicular

FIG. 8

Case 2. After operation.

FIG. 9

Case 2. After operation.

joint in professional athletes, using the author's method, are reported.

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VERTEBRAL EPIPHYSITIS AND OSTEOCHONDRITIS

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The object of this presentation is to review the work of Scheuermann and Schmorl as read in the original language; to then present three cases of dorsal kyphosis with comments thereon.

This paper will not deal with the embryological, anatomical, physiological, or historical aspects of the spine or spinal diseases. Readers so desiring will find appropriate articles dealing with these specific phases in the bibliography.

In reviewing the literature, articles were found dealing with diseases of the intervertebral disc, dorsal juvenile kyphosis, vertebral epiphysitis, prolapsus of the nucleus pulposus, and other conditions; all treated the same problem, but presented conflicting views. This confusion may have resulted from failure of the authors to read Scheuermann's original article and Schmorl's publications in the original language, for much that has been written in our periodicals seems to have been based on other than first sources, so that the original contentions of the authors have been lost or misapprehended.

From Scheuermann's original article we receive the following description of a clinical entity, "*Die Lehrlings Kyphose*" (The Apprentice's Kyphosis):

1. Clinical—Round back (dorsal kyphosis); painful back; irreducible deformity (contradistinction of dorsum rotundum); found especially in males from fourteen to eighteen years of age.
2. Roentgenographical—An area of osteitis on the diaphyseal side of the epiphyseal line; wedging of vertebra in the dorsolumbar region.

Analysis of Scheuermann's work is relatively easy, but when one turns to the reading and translation of Schmorl's work it becomes very difficult because of his involved diction. Furthermore, it must be remembered that Scheuermann is a clinician while Schmorl is a pathologist, having recorded observations on 7000 vertebral columns removed at autopsy. With this wealth of material from which to draw, one can well understand his difficulty in presenting one phase of his subject without digressions.

Schmorl's description is as follows:

1. "*Ausbuchtugen*" (outpouchings of the nuclear substance into the spongiosa) through
2. Congenital or traumatically produced orifices in the cartilaginous plate.
3. The kyphos is the result of loss of nuclear substance, which

interferes with the physiological function of the spine, causing

4. Failure of endochondral growth in the cartilaginous interface and wedging. He does not use the term osteochondritis.

One must come to two conclusions:

First, Schmorl saw the termination of the disease Scheuermann described. There exists, however, a gap in our knowledge in that we do not know the subsequent course of Scheuermann's cases. It would be invaluable if we could trace the eighty-six cases he reported and reexamine them eleven years after their original observation.

Second, there may be three or more separate diseases or manifestations of the same disease which, until the present time, have not been separately identified. As Dr. William Evans of Detroit suggests, there may be three pathological entities: (1) vertebral epiphysitis (Scheuermann); (2) osteochondritis of the cartilaginous interface (Schmorl); (3) a combination of these two. It is not to be supposed that only these three exist, or that they represent three etiological entities. They may or may not simply present roentgenographic evidence of pathology of several origins.

The following three cases are presented with an attempt to analyze the group to which they belong. The study of these cases and the conclusions drawn therefrom cannot be regarded as final, but only as additional information upon a difficult problem.

FIG. 1

Case 1. Vertebral epiphysitis (healing stage). Recent films of first, second, third, and fourth lumbar vertebrae. Note notching anteriorly, and evidence of abnormal pressure posteriorly.

CASE REPORTS

CASE 1. V. D., a white female, aged twenty years, a school teacher, of slender physique, was referred to the Hospital by Dr. J. L. Atlee, Sr. on February 2, 1929, for a roentgenographic examination of the spine. Her complaint was "pain in the back" (dorsolumbar region) of several years' duration, with no known traumatic or infectious cause. The pain was accentuated by menstruation and may be more adequately described as an ache. Rest in bed alleviated it, but did

FIG. 2

Case 2. Late stage of vertebral osteochondritis with wedging, narrowing, and numerous nuclear prolapses.

FIG. 3

Case 2. Roentgenogram of section of specimen removed at autopsy.

FIG. 4

Case 3. Vertebral epiphysitis and osteochondritis. Typical Scheuermann's disease, notching at arrow with definite wedging; also Schmorl's nuclear prolapsus.

not cure it. During the intervening three years the pain gradually disappeared during the intermenstrual interval except after heavy lifting.

Examination revealed a thin, pale, fragile, young woman, with loss of the lumbar lordosis and replacement by slight kyphosis in the painful area. Otherwise, her physical condition was not noteworthy.

Roentgenograms revealed notching of the anterosuperior edges of the first, second, third, and fourth lumbar vertebrae in the position noted by Scheuermann, with wedging of the first and third vertebrae. The edge produced by the epiphysis remained intact. The intervertebral discs were narrowed, but there were no nuclear prolapses. The patient was reexamined periodically for three years. The punched-out area was unchanged, with slight peripheral calcification and the vertebral interfaces definitely irregular and calcified (Fig. 1).

We believe that this is a case of true epiphysitis, diagnosed after the union of the epiphyses. The triangular shadow of the epiphysis is only seen from fourteen to eighteen years of age. Our patient was twenty; therefore, she should present a later stage in the course of this disease. It is noteworthy that no prolapsus of the nucleus pulposus exists; and the illustrations of Scheuermann's original article do not show this prolapse.

Case 2. L. S., a tall, stalwart, white male, aged thirty-eight years, while fighting a barn fire on July 9, 1929, was struck across the dorsolumbar junction by a falling timber. He fell, developed a paraplegia of six hours' duration, and was referred to the Hospital by Dr. D. H. Anderson for a roentgenographic examination. Thereafter the patient suffered from pain in the back which was relieved when he assumed the recumbent posture.

The past history is significant. The patient, six feet and three inches tall, at fourteen years of age was a shoe machine operator, bending over a machine ten hours a day, during which time he developed a "bowed back". He worked at this occupation for ten years and then volunteered for service at the outbreak of the World War. Upon his return from overseas duty, his family noticed a marked lessening of the kyphosis, which, however, recurred upon his resuming his former occupation.

Roentgenographic examinations were made on several occasions during the subsequent three years, with no appreciable change in the findings. The films showed a diffuse nuclear prolapse, involving many vertebrae on one or both surfaces; distinct narrowing of the intervertebral spaces, especially anteriorly; wedging of the bodies; and increased irregular calcification of the body interfaces with sharpening of the anterior corners (Fig. 2). Scheuermann's notch was not preserved.

On June 14, 1932, the patient chose a violent death and an autopsy was performed. The only findings of interest pertain to the vertebrae, which fulfill in every detail the pre-autopsy opinion (Fig. 3).

We believe that this patient had osteochondritis of the cartilaginous plate, of a very severe grade; whether or not he had dorsal epiphysitis, we are unwilling to state. His history is very suggestive except that we have no history of pain during adolescence. This may be the end of the life cycle of the disease which Scheuermann described in adolescents, and the disease which Schmorl found at autopsy. We do not know, but, if this is so, the importance of the osteochondritis far outweighs the epiphysitis. Although the autopsy completes the case in so far as the spine is concerned, we deplore the failure to examine the cord for injury.

Case 3. G. R., male, aged fourteen years, fell from a cherry tree on September 20, 1931, and was brought to the Hospital complaining of pain in the left wrist and back. Before the accident the child had been perfectly well. Roentgenograms showed a Colles' fracture of the left wrist, a well developed vertebral epiphysitis (Scheuermann type), and probably a compression fracture of the dorsal surface of the eighth dorsal vertebra. Accurate diagnosis here was difficult because of the high degree of wedging, due to the coincident epiphyseal disease. Physical examination showed a well developed kyphosis at the point of suspected fracture.

Roentgenograms of the spine showed Scheuermann's notches on the twelfth dorsal vertebra and on the first and second lumbar vertebrae, and marked nuclear prolapses of long standing. There seemed to be a mild degree of osteoporosis of all the vertebral bodies (Fig. 4).

Six months later, after hyperextension in a body cast, the patient was reexamined, but there was no apparent change, and no relief of vertebral pain.

We believe this to be a case of vertebral epiphysitis with severe osteochondritis. The fall from the cherry tree accentuated an already existing spinal disease.

In conclusion, let it be understood that we are making a differentiation upon the occurrence of disease in two places,—one, the diaphyseal side of the epiphyseal line on the interfaces of the vertebral bodies; two, the prolapse of the nucleus pulposus, due to pathology of the cartilaginous plate, probably an osteochondritis. From the medicolegal point of view it is important to note the onset of symptoms which were not amenable to treatment following a definite trauma.

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A NEW METHOD OF ARTHRODESIS OF THE SHOULDER JOINT, INCORPORATING THE CONTROL OF THE SCAPULA

BY A. LEO BRETT, M.D., BOSTON, MASSACHUSETTS

The difficulty of establishing ankylosis of the shoulder joint in the position of election has been experienced by all operators. In the majority of cases, the loss of position is due to the surgeon's inability to control the action of the scapula until bony union has taken place. Unless this structure is definitely immobilized following the arthrodesis, protective spasm, as afforded by the teres major and teres minor and to some degree by the supraspinatus and infraspinatus, causes the scapula to draw outward toward the humerus, thus making the scapulohumeral angle more acute than is desired. Extrinsic means alone, as provided by the fixation methods in use, cannot be relied upon to check the activity of the scapula, regardless of whether the arm is held continuously in the position of abduction.

Confronted with the problem of devising a means that would definitely assure immobilization of the scapula, the author has sought by the use of a bone graft to establish stability. The method evolved assures maintenance of position until union is solid. It also has the additional advantage of allowing early mobilization. Thus far, the technique has been used in two cases, and the results have been functionally perfect.

LITERATURE

A survey of the methods of arthrodesis that have been introduced shows that the efforts of operators have been directed primarily toward establishing bony union between the humeral head and the glenoid (Albert [1], Karewski [2], Bothezat [3], Hoffa [4], Tubby [5], Vulpius [6]). To the pioneers in the field of arthrodesis, the achievement of this end—the first prerequisite of a successful arthrodesis—also presented a great deal of difficulty. Within recent years, through the introduction of bone grafts, the problem of securing solid fixation has been practically solved, and a union may be obtained that allows good voluntary control of the arm (Vulpius [6], Albee [7], Key [8], Straub [9], Immelmann [10]). But, while the range of abduction obtained may be sufficient to allow the patient to raise his hand even to his mouth, the motion is not so complete as is desirable, or as may be established under the method of treatment that is here suggested. None of the methods in use provides for fixation of the scapula other than by extrinsic means, which are not reliable, and hence the favorable angle for arthrodesis is lost, with a consequent limitation of voluntary abduction.

The author's experience with the customary methods of treatment has not, on the whole, given gratifying results, in spite of the exercise of

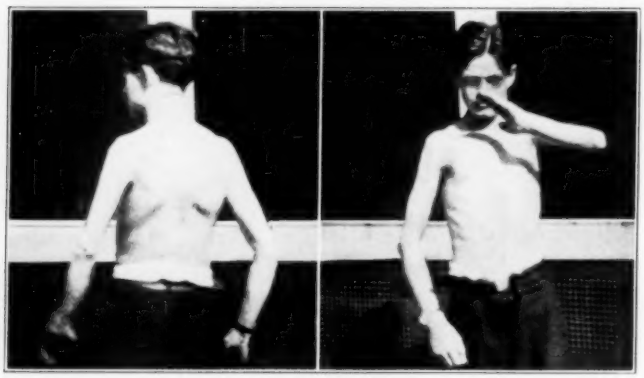

FIG. 1

N. D. End result, seven years after arthrodesis, showing the range of voluntary abduction.

great care in carrying out the details of technique. The patients have obtained a perfectly solid union with good voluntary control, but there has always been a certain limitation of abduction, due to inability to maintain the position of election. Figures 1 and 2 show clearly the loss of position that occurs following an arthrodesis by one of the customary operative methods in use. The patient had had infantile paralysis. Arthrodesis of the joint was attempted by breaking down the acromion process, denuding of cartilage the under surface of the acromion and the articular surfaces, and establishing contact. The resulting union was

FIG. 2

N. D. Roentgenogram, taken one year after arthrodesis, showing excellent bony union, but the loss of elective position.

solid, and the patient has good voluntary function sufficient for a useful arm, but there is not a complete range of abduction, due to the acute scapulohumeral angle.

INDICATIONS

Arthrodesis of the shoulder joint has a wide field of applicability. The procedure is indicated in complete and permanent paralysis of the deltoid, usually due to infantile paralysis. As in all cases of infantile paralysis in which surgical intervention is considered, the cases must be carefully selected for operation, and the presence of a useful hand is essential. Arthrodesis should never be advised until at least one year has elapsed from the onset of the disease; for recovery of power, either complete or in part, is always possible within this period.

In tuberculosis of the shoulder joint, especially in the adolescent or the adult, arthrodesis is indicated not only to arrest the activity of the bacillus, but also to relieve pain and restore function. It should be performed as soon as the definite diagnosis is made, providing the age and physical condition of the patient present no contraindications.

Arthrodesis is a more effective means of restoring health and function to the tuberculous joint than are other methods of treatment. Heliotherapy, for instance, may provide an excellent functional result, but it is not unusual to see a joint treated in this manner recover with a painful fibrous union, or with a bony union in poor position that allows only a limited range of motion. Arthrodesis also has certain advantages over excision in that it restores a functional power that is more nearly normal, it fits the member for the resumption of hard labor, if necessary, and it ensures relief from pain.

Arthrodesis is also indicated occasionally in chronic painful conditions of the shoulder joint, due to an arthritic process, or resulting from a severely comminuted fracture of the head of the humerus or of the glenoid. In the case of the laborer, fixation offers the most satisfactory means of relief, as the function that would be restored by other operative procedures—such as an arthroplasty or a reconstruction operation—might continue to be accompanied by pain under heavy use.

Other indications for arthrodesis are presented occasionally in an obstetrical paralysis with a partial dislocation of the joint, in traumatic brachial paralysis, and in a recurrent dislocation of the shoulder joint, when all other recognized stabilizing operations fail, and when the patient is prevented by the disability from resuming his occupation.

AGE FOR ARTHRODESIS

An arthrodesis of the shoulder joint may be successfully performed at any time after eight years of age. This minimum age limit must be respected, for before this age ossification has not progressed sufficiently to assure the success of the procedure. In young patients, the years between twelve and fifteen are undoubtedly best for stiffening the shoul-

der, as operation can be performed at these ages without interfering with the growth of the arm. The procedure has been used successfully by the author in several cases of infantile paralysis where the patients were between the ages of eight and ten years, and the results have justified the operation in that the restoration of function stimulated the growth.

POSITION FOR ARTHRODESIS

The position most advantageous for fixation of the humerus to the scapula is that which allows the compensatory action of the scapulothoracic musculature to be utilized completely. When the extremity is ankylosed in such position, the patient can voluntarily abduct his arm to above the level of his head; he can lower it to the proximity of his side; and he can rotate it backward and forward to a limited extent. The loss of a certain amount of rotation, which must necessarily occur on account of the anatomical position of the scapula, is the one drawback to arthrodesis, but, fortunately, the limited degree of rotation made possible by the loose muscular suspension of the scapula is sufficient for practical purposes. In the adult, the best position for arthrodesis is approximately seventy degrees of abduction and approximately twenty degrees of anterior flexion. In the child, the position of optimum function is about eighty degrees of abduction.

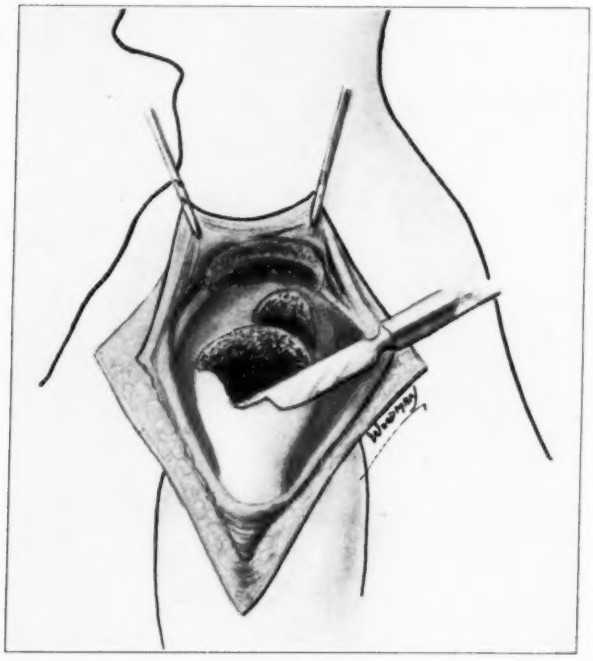

FIG. 3

The joint surfaces and under surface of the acromion have been denuded of cartilage, and the acromion has been broken down preparatory to being brought into contact with the head of the humerus.

OPERATIVE TECHNIQUE

When the case is one in which contractures of the arm would prevent placing the extremity in proper position following the operation, the contractures must first be overcome by maintaining the arm in abduction in a plaster bandage for a sufficient period preceding surgical intervention.

A curved skin incision over the shoulder joint, or a straight incision beginning high above the acromion and running downward

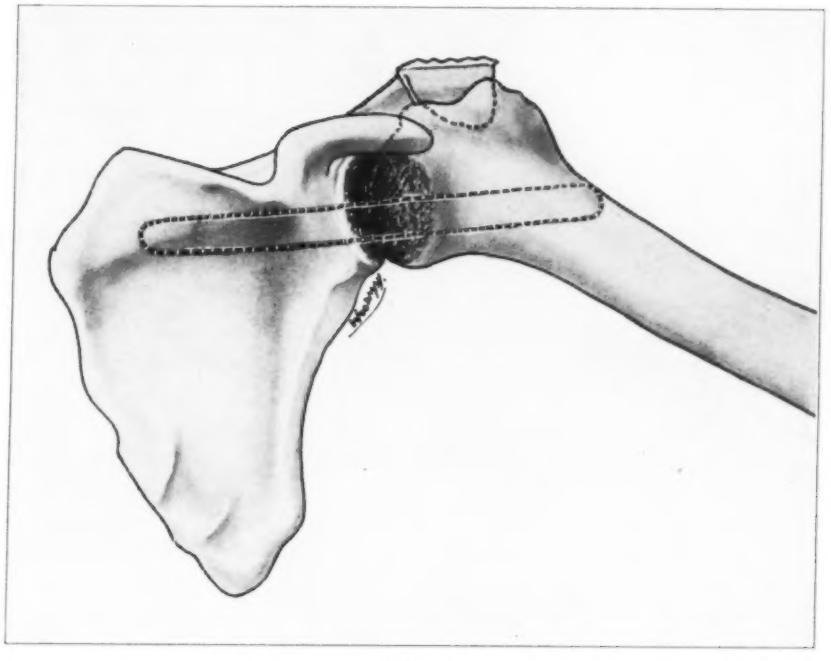

FIG. 4

Showing the massive tibial graft in place.

parallel to the shaft of the humerus, may be used. The fascia is incised, and the tissues and muscles are freed and retracted as required. The capsule is split longitudinally, and, with a periosteal elevator, dissected back from its attachment on the anatomical neck of the humerus, except for the portion about the posterior third of the bone. The head is then forced out of the glenoid by rotating the arm outward.

The surfaces of the head, glenoid, and under side of the acromion process are carefully denuded of cartilage, so that the cancellous bony structures are exposed. Care must be taken to remove the cartilage on the peripheral edges of the glenoid in order that bony contact can be established with the head (Fig. 3).

With an assistant holding the arm in the accepted position for arthrodesis—that is, in seventy to eighty degrees of abduction and in twenty to thirty degrees of forward flexion—a drill hole about one-quarter of an inch in size is bored from just below the greater tuberosity through the humeral head in line with the center of the glenoid, then through the glenoid, and finally into the spine of the scapula, until the end of the drill is palpable in the outer scapular musculature. In the adult, this hole is sometimes enlarged to three-eighths of an inch by means of a larger drill.

The bone graft is then removed from the tibia. The author prefers to wait until the bed is prepared before removing the graft, to be assured of a fresh transplant. A massive graft, three-eighths of an inch in width,

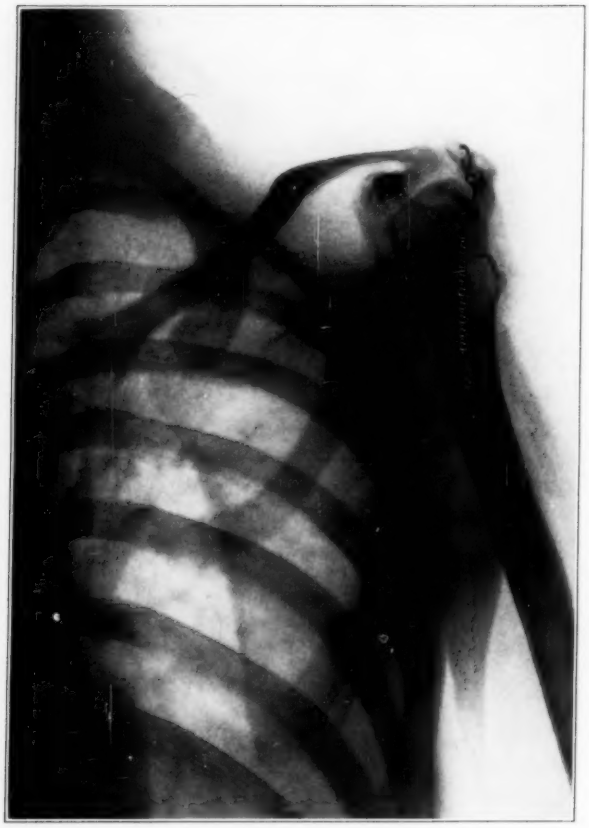

FIG. 5

Case 1. M. L. Roentgenogram before arthrodesis, showing flail joint with considerable deformity of humeral head. Note wire leading from acromion to head, used in previous attempt at arthrodesis.

and varying in length from three to five inches, depending on the size of the bone structure of the patient and his age, is taken. The operator then narrows down the graft with a rongeur, shaping it so that it will fit snugly.

With the arm still held in the position of election, a hole is drilled through the upper border of the head and glenoid, and the humerus is tied in place with kangaroo tendon.

The graft is now driven through the head, through the glenoid, and out through the spine of the scapula, until it is palpable at the end of the drill hole. If any of the graft protrudes from the humerus, it may be removed with a rongeur (Fig. 4).

The acromion process, which has been previously denuded of cartilage, is broken down in the manner of a greenstick fracture, so that it will present the broadest surface possible in relation to the head of the humerus. It is then fixed to the head by means of stay sutures of chromic catgut No. 3, or kangaroo tendon, which is passed through the drill holes already made. This contact helps to establish stability and to hold the head against the glenoid. The capsule is sutured down on the humerus for further stability. The musculature and skin are sutured. A well fitting plaster spica, embracing the shoulder and chest down to the umbilicus, and extending from the neck to the fingers, is applied, with the shoulder in the position of seventy to eighty degrees of abduction and twenty to thirty degrees forward of the frontal plane, as the case may indicate.

The plaster spica remains intact for at least two months. At the end of that time the upper half is removed to permit baking and massage,

and the patient is instructed to begin raising and lowering his arm voluntarily. This after-treatment is continued for a period of two weeks or a month, depending upon the evidence of union as shown in the roentgenogram. At the end of this time, the entire spica may be removed, and exercises given daily to produce hypertrophy of the scapular muscles.

FIG. 6

Case 1. M. L. Roentgenogram, taken four months after arthrodesis, showing bony union with arm in approximately seventy-five degrees of abduction and twenty degrees of anterior flexion. Note graft in place, with beginning of absorption.

CASE REPORTS

CASE 1. M. L., male, aged twenty years, when first seen in July, 1930, had a perfectly flail right shoulder as the result of infantile paralysis in childhood. The deltoid had no power; the biceps and triceps were weak. The power in the forearm and scapular muscles was good. Five years previously, an arthrodesis by means of wiring had been unsuccessfully attempted by a surgeon in Greece.

On July 31, 1930, an arthrodesis was performed according to the technique described. The wire, when removed from the acromion, broke into several pieces (Fig. 5). The head of the humerus was misshapen, and the glenoid was buried in scar tissue.

Four months after the arthrodesis, a roentgenogram showed solid union with the arm in approximately seventy-five degrees of abduction and twenty degrees of anterior

FIG. 7

Case 1. M. L. End result, two and one-half years after arthrodesis, showing range of voluntary abduction.

flexion (Fig. 6). By January, 1931, the patient could raise his arm above a right angle, a movement that he had not been able to carry out since early childhood.

In January, 1933, two and one-half years after the operation, the arm functioned perfectly. The patient was able to put his hand on top of his head, to lower it to within a few degrees of his side, and to do laborious work (Fig. 7).

It is interesting to compare the result pictured in Figures 1 and 2 with those of this case in which a more complete range of abduction was obtained, in spite of the fact that the humerus was malformed and part of the humeral head had to be removed.

CASE 2. R. D., male, aged eighteen years, when first seen in April, 1927, complained of pain, soreness, and the inability to raise his left arm. The symptoms had been of three years' duration and dated back to a questionable injury received while playing football. There had been a gradual increase of the symptoms and during the three months previous to examination they had been considerably worse. On examination, the shoulder was found to be considerably atrophied, and all motions were markedly limited and protected by spasm. The roentgenogram showed evidence of joint destruction. The diagnosis of a tuberculous shoulder was made.

On May 10, 1927, an arthrodesis was attempted by one of the customary methods. The joint surfaces and the under surface of the acromion were denuded of cartilage, the parts fitted together and tied in position, and a bone screw passed down through the acromion into the head for further fixation. The recovery was uneventful, and a roentgenogram, taken in September, 1927, showed that the position of the arm was holding fairly well, and the bone screw absorbing.

During the next few months it was found that the patient could not discard his brace because of the mobility of the joint. When, on March 19, 1928, there still remained a few degrees of motion, although apparently there was fibrous union at the acromion process, it was decided to attempt another arthrodesis.

On April 12, 1928, the operation using the massive tibial graft was performed. In addition to using this graft, another step was taken to assure arthrodesis in this case in

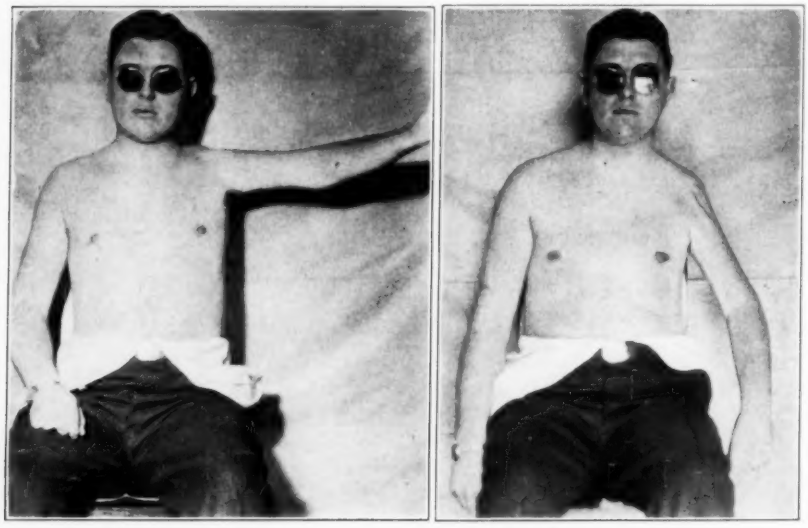

FIG. 8

Case 2. R. D. End result, five years following second arthrodesis, showing excellent range of voluntary function.

which a previous attempt to fix the arm had failed. A Y-shaped periosteal graft was laid from the acromion to the head and shaft, each branch of the Y extending down over the head to the shaft where it was tucked in subperiosteally.

In February, 1929, the patient could voluntarily abduct his arm to 100 degrees and extend it forward to forty-five degrees, and within a few months he was able to resume his occupation as a baggageman. In January, 1933, nearly five years after the operation, the functional result was perfect (Fig. 8).

CONCLUSION

The type of arthrodesis that has been described not only assures good bony union, but also establishes complete fixation of the scapula in relation to the humerus. It has the additional advantage of establishing arthrodesis in a shorter period than is possible under the general methods in use; instead of a six months' period of immobilization, the patient may use his arm at the end of the third or fourth month.

The results obtained in the two cases in which the technique has been carried out have been a source of satisfaction to both the patient and the operator. A complete range of motion has been obtained, and the patients have been able to resume laborious work within a period of four months following the arthrodesis.

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PREVENTION OF SUBLUXATION OF THE HUMERAL HEAD FOLLOWING OPERATIONS FOR ARTHRODESIS OF THE SHOULDER JOINT

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From the University of Pennsylvania, Philadelphia

Dislocation of the humerus following operations for arthrodesis of the shoulder joint is a frequent occurrence. This postoperative catastrophe has arisen regardless of the type of arthrodesing procedure employed. To prevent it numerous methods have been devised, none of which has proven entirely satisfactory.

A modification is presented which promises to prevent humeral subluxation. It may be used in any of the standard operations for arthrodesis of the shoulder joint. The procedure of choice for arthrodesis is supplemented by a Nicola operation.

The long head of the biceps is sectioned at the distal end of the bicipital groove. The proximal end of the tendon is passed through a hole drilled from the lateral surface of the greater tuberosity through the long axis of the humeral head. The articular surfaces of the humeral head and glenoid are denuded of cartilage. The periosteum is resected from the tip of the acromion if this structure is to be used. The arm is placed in the classical position for fusion and the head of the humerus firmly contacted with such of the scapular structures as desired. That portion of the long head of the biceps passing through the drill hole in the head of the humerus is drawn taut. It is securely sutured to the distal end of the same tendon and to adjacent deep tissues in such a manner as to permanently maintain the tautness.

The above procedure has been used in several cases. It has been found to aid in maintaining coaptation of the raw-bone surfaces and to prevent subluxation of the humeral head.

ARTHROPLASTY OF THE ELBOW *

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The patient with a stiff joint seeks operation to attain mobility and usefulness of the joint. It remains for the surgeon to realize that a reasonable degree of stability and muscular control is quite as important as mobility to satisfactory postoperative function, and to the ultimate contentment of the patient. To gain the latter at the expense of the former is to bring down a storm of criticism on one's head. A flail joint can be just as annoying as a stiff joint. It is, indeed, the difficulty of gaining at the same time mobility, stability, and active muscular control of motion in both flexion and extension which has placed arthroplastic operations in a class by themselves, requiring the keenest prevision and surgical judgment, and the highest technical skill.

Although stability at the elbow may not be as important as in a weight-bearing joint, a fair degree of stability is most essential to certain movements, particularly active control in extension. A man cannot wield a hammer or saw with a flail elbow, the extension of which depends on gravity; and lifting a weight above the head, whether it be books or bricks, is an important movement in everyone's daily routine, depending quite as much on stability and control at the elbow as on mobility.

In a remade elbow, the most certain way of gaining the desired stability and muscle control is by providing a sufficiently long bone lever for the triceps to pull upon. In this way, active extension is restored in full as a balancing influence or antagonistic pull to that of the biceps and other muscles. Active flexion is present in all movable elbows following arthroplasty; whereas active extension is rarely restored because of inadequate olecranon leverage. The original technique which is presented herewith possesses not only the advantage of restoring olecranon leverage with active extension and stability, but it also affords the freest access to modeling the joint (Figs. 1-A and 1-B).

AUTHOR'S TECHNIQUE

The approach is by a skin incision on the posterior aspect of the joint, beginning just over the tip of the olecranon and extending proximally about four inches directly over the superficial posterior crest of the ulna. The skin and subcutaneous tissue are dissected laterally. The olecranon and about three and one-half inches of the posterior crest of the ulna are developed, care being taken not to disturb either the attachment of the

* Read before the American Orthopaedic Association at Washington, D. C., May 9, 1933.

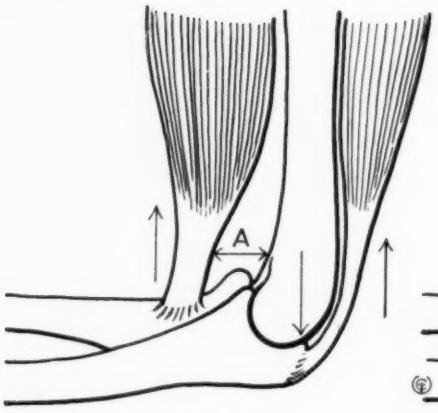

FIG. 1-A

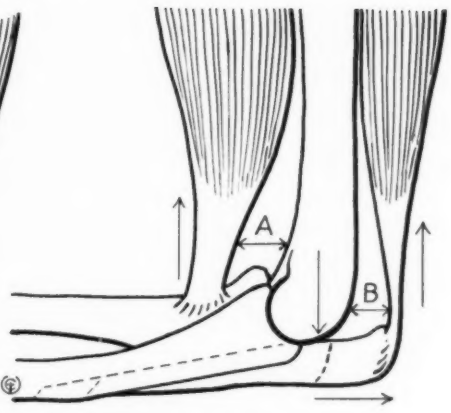

FIG. 1-B

Diagrams showing provision for leverage action of triceps muscle by sliding olecranon process posteriorly: *A* indicates leverage for action of biceps; *B*, for action of triceps.

triceps muscle or the ulnar nerve. In some instances, when infection or severe trauma has destroyed or shortened the olecranon process, the triceps muscle is developed to its bony insertion at the posterior surface of the ankylosed joint; this, with its bony attachment as a part of the larger bone fragment, is later turned back as follows.

With a single motor saw, held at an oblique angle, cuts are made in the proximal portion of the ulna, converging both in cross section and longitudinally, and extending distally from the olecranon process or insertion of the triceps muscle about three and one-half inches. The fragment thus formed, including the proposed new olecranon process, is then turned upward with the triceps muscle attached to its proximal end as a hinge. Thus, complete exposure is obtained for modeling the new joint from the posterior and lateral aspects.

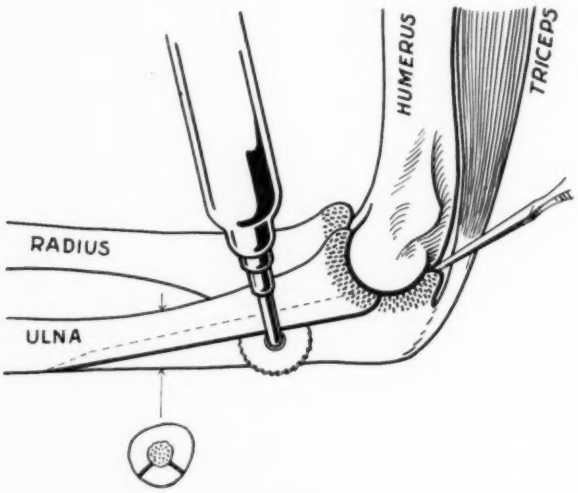

FIG. 2

Diagram showing converging saw cuts on upper posterior surface of ulna, including whole olecranon process.

The soft parts to the side are then dissected from the bone and the ulnar nerve is either meticulously avoided or dissected out and held laterally by a tape.

Sufficient bone is then removed to

permit free flexion and extension of the ulna and radius upon the condyles of the humerus, and to allow adequate space to receive the fascia-fat graft, which will line the new joint. Care should be taken to so mold the joint surfaces that a free and smooth range of motion is allowed. This should be tested out by putting the arm through the full range of flexion and extension.

All roughness and irregularities are next removed from the freshly cut bone surfaces of the humerus, radius, and ulna, and the bone surfaces are still further smoothed and possible future bleeding prevented by repeated blows of a mallet against the large end of a bone drift or some other rounded instrument, held against the bone surfaces.

As a still further hemostatic influence, the newly formed elbow is packed with a hot saline compress and held temporarily in position by means of towel clamps, while a graft of fascia and fat of sufficient size to cover the newly formed joint surfaces on the humerus, ulna, and radius is obtained from the outer surface of the thigh. It is important that the fat should be sufficient in amount to fill in the bony interspaces, but it should not result in too much tension upon the closure stitches.

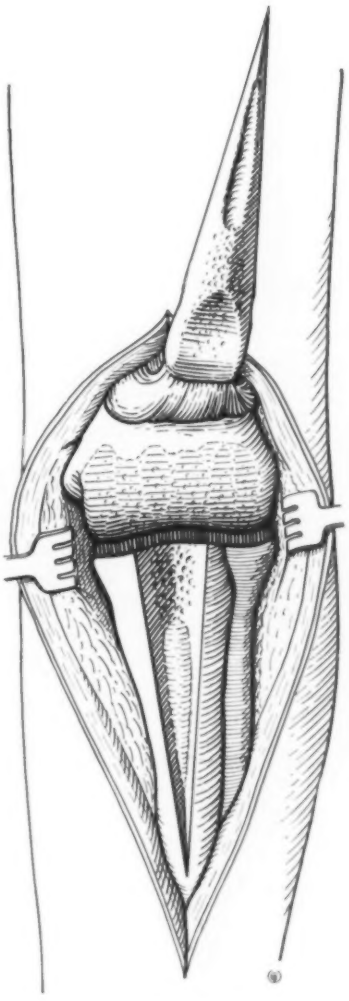

FIG. 3

Diagram of olecranon-ulna fragment turned upward, showing wide exposure afforded.

With the arm flexed, this aponeurotic tissue is sutured in place, care being taken that every vestige of raw-bone surface is covered on both elements of the newly made joint. The arm is then extended, the olecranon-ulna fragment turned downward into its groove and slid far enough proximally and posteriorly to furnish a long posterior lever for the full extension and stabilizing action of the triceps muscle (Figs. 2 and 3).

Drill holes are then made opposite each other in the ulnar end of the sliding olecranon-ulna graft, and in the gutter in the ulna itself. At the olecranon end of the graft, a single drill hole is made in the ulna only, just lateral to the gutter. Medium-sized kangaroo tendon is drawn through the holes in graft and gutter at the ulnar end by means of the cervix needle, and the graft securely tied in place. At the upper end, the

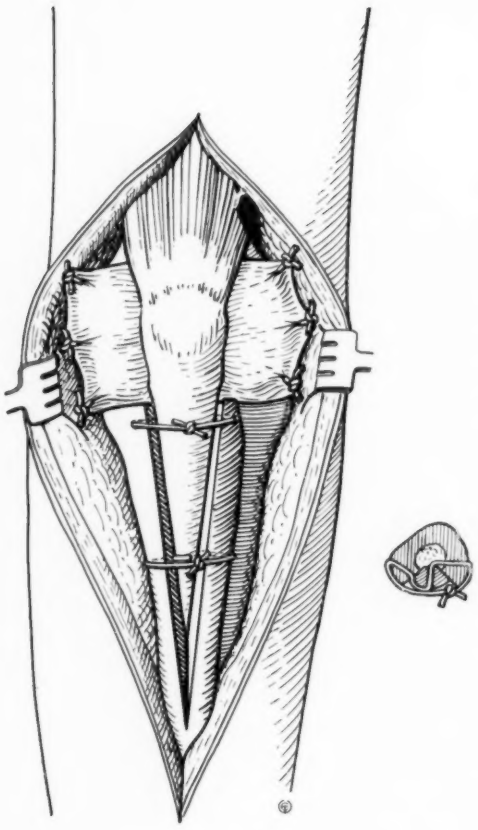

FIG. 4

Diagram showing fascia-fat graft sutured in place and olecranon replaced in its gutter.

tendon is passed through the hole in the ulna and simply tied around the graft (Figs. 4 and 5).

The subcutaneous tissues are then approximated with great care, with No. 1 chromic catgut, over the fat and fascia graft as well as the sliding bone graft and ulna, and the skin is closed by continuous suture with No. 0 plain catgut. The suture holes and the line of suture are thoroughly puddled with a three and one-half per cent. tincture of iodin, and the excess wiped off. A generous dressing of gauze and sterile cotton and a plaster-of-Paris cast are applied from the base of the fingers to the axilla, with the arm in the flexed position. The cast is left on for a period of three weeks. After its removal, massage and manual manipulation should be begun immediately and continued daily for a period of at least one month. One need not fear displacement of the olecranon-ulna graft, for, because of its length and the inlay method of insertion, the union of the fascia and soft parts drawn over the graft at the time of closing the wound will prevent such displacement even before bony union has taken place. Therefore, one need not wait for solid bony union before beginning active and passive motion and physiotherapy, as would be necessary if the olecranon had been merely severed.

In regard to a telescoping effect produced by the sliding olecranon-ulna graft, it might be said that the same effect could be secured by displacing the ulna with the radius posteriorly upon the humerus at the newly formed joint; but it should be realized that this would necessarily be at the expense of the leverage action of the radius anterior to the joint and would not allow the biceps and other muscles to retain their full power of flexion. Flexion, by action of the biceps on the anterior arm of the lever, and extension, by the antagonistic action of the triceps on the newly formed olecranon, are both preserved by the method used.

On the other hand, if, following arthroplasty, the leverage action of the olecranon process is lost or diminished in length—as is usually the case—slight or no leverage action is afforded to force the arm into extension by triceps-muscle action. The forearm extends passively, merely by its own weight, and can do so only when the arm is in certain positions.

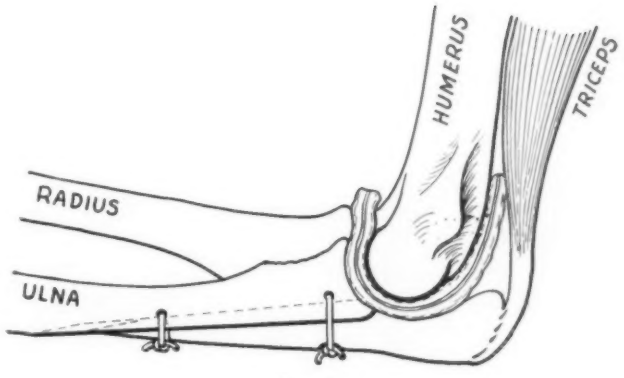

FIG. 5

Lateral view, showing newly formed joint with an adequate olecranon lever.

The ample approach afforded is also very important because, even with the aid of the x-ray, one cannot be sure what complications may be encountered at operation.

THE SOURCE OF THE APONEUROTIC FLAP

Some surgeons take the flap to line the joint from the arm instead of from the thigh. The preference for doing a large and more difficult operation locally rather than opening up a secondary field is the old bugaboo which has been such a stumbling-block. Flaps taken from the arm are not nearly as satisfactory as those from the thigh, for the fascia is not sufficiently dense, the fat is not thick enough, and it is very hard to get a flap large enough to cover both elements of the newly formed joint. A pedicle is an absolute delusion and most unnecessary: first, because a free fascia-fat graft will become vascularized in a short time and remain viable; and, second, because whatever blood supply there happens to be in the pedicle is very likely to serve no purpose in that it becomes occluded either from the pressure of the twist which is exerted upon the pedicle or from traumatization.

INDICATIONS FOR ARTHROPLASTY

It is universally agreed that the elbow is a particularly favorable joint for arthroplasty. However, before advising operation, one must always consider the origin of the ankylosis (traumatic or infectious), its type (fibrous or bony), the age and social status of the patient, and the condition of the bone, musculature, and skin.

Bone atrophy, or osteoporosis, adds to the difficulties of operation. The important muscles which control the joint should be free from extensive infectious or traumatic scarring.

Arthroplasty is most successfully performed in patients between the

FIG. 6-A

Case J. J. S. Preoperative roentgenogram, showing complete bony ankylosis of many years' duration, resulting from multiple arthritis. An arthroplasty four years previously had resulted in complete failure and reankylosis. Complete loss of olecranon process is shown.

ages of twenty and forty years. It should never be undertaken until epiphyseal growth has nearly ceased.

The patient should be in excellent general health. Routine checking of all possible sources of infection is a wise preoperative precaution. MacAusland reports cases in which he encountered serious postoperative complications,—in one instance, because of secondary wound sepsis from an abscessed tooth; and, in another, from an acute fulminating abscess of the appendix. The presence of eburnated bone, extending on either side of the joint, lessens the chances of success, but does not definitely contraindicate arthroplasty.

FIG. 6-B

Case J. J. S. Postoperative roentgenogram, showing reconstructed olecranon process.

In general, however, one may say that the contraindications to arthroplasty of the elbow are few. In view of the great inconvenience and awkwardness resulting from a stiff elbow, the patient should be given the benefit of mobility (Figs. 6-A and 6-B).

SUMMARY

The advantages of the method herewith proposed may be summarized as follows:

1. The approach gives the freest exposure possible without jeopardizing important structures. This point cannot be too highly emphasized because the very success of the operation depends upon the most meticulous care in the removal of all peripheral bone (especially in front of the joint) as well as the suture of the interposed fascia-fat graft.

2. It enables the surgeon to remove sufficient bone to insure complete freedom of motion without jeopardizing stability. Stability is brought about by the antagonistic pull of the flexors and extensors upon a lever whose fulcrum comes at the newly formed joint, the posterior arm of which (the olecranon) is long enough to allow sufficient antagonistic action of the triceps to bring this about.

3. Early immobilization without danger of separation or non-union of the ulnar parts is made possible by this use of the long, sliding, inlay olecranon-ulna graft, to which the insertion of the triceps is undisturbed, and the accurate mortise fit of this graft into its proper gutter.

THE RATIONAL TREATMENT OF BONE TUBERCULOSIS*

BY CHARLES K. PETTER, M.D., OAK TERRACE, MINNESOTA

Department of Surgery, University of Minnesota and Glen Lake Sanatorium, Oak Terrace, Minnesota

We are all cognizant of the facts that tuberculous disease of bone is the result of hematogenous implantation of tubercle bacilli in that structure, and that these bacilli are carried from a bronchial gland, mesenteric node, or pulmonary focus. Therefore, when one sees clinical tuberculosis of a given joint, he cannot tell, off hand, how many latent foci exist in other joints or organs; for there certainly is no good reason to believe that during a period of bacillaemia, a few organisms are going to lodge in the fine end arteries of a single bone and miss all the other joints, the kidneys, skin, and lymph nodes. In fact, reviewing a series of our extrapulmonary cases, we find multiple lesions in fifty-five per cent., while an active pulmonary disease accompanies the bone lesions in eighty-five per cent. With this as a background, it is only logical to conclude that adequate treatment of orthopaedic tuberculosis should begin with the general hygienic measures so well established in the management of pulmonary tuberculosis,—*i.e.*, bed rest, good food, and fresh air; to which is added a most valuable adjunct,—namely, heliotherapy.

During such a period of conservative therapy one can determine the presence or absence of other foci, active or latent, and afford the patient an opportunity to build up his resistance to the disease, reducing likelihood of complicating lesions and the ultimate period of disability.

There are really three schools of therapy in bone tuberculosis. First, the heliotherapists, who feel that solar therapy and prolonged general rest bring about better results than the surgeon's knife. Such a régime requires long periods of hospitalization. In our country this is economically bad, except in children, and does not as a rule produce bony ankylosis. One point in favor of the treatment advocated by this group, however, is the fact that all lesions in all parts of the body are benefited by the régime while the particular lesion in question is being treated.

The second group believe in ambulant treatment with brace or cast, or else they immediately perform an arthrodesis, lay in a bone graft, or amputate a member, without examining more of the patient than the particular portion causing local symptoms. The primary period of disability is short and the fixation secure, for the particular lesion operated upon; but how many of these cases subsequently require hospitalization for another focus which was active but neglected at the time of the original operation? A good many of the ambulatory cases ultimately come to more radical surgery and longer disability than would have been necessary, had a régime of general rest therapy been instituted immediately. And further, if adequate preoperative and postoperative treatment is not given, patients with bone grafts as splints show progres-

*Read at the Annual Meeting of the Minnesota Orthopaedic Society, Rochester, Minnesota, May 22, 1933.

sion of the disease while the bone graft "takes", resulting in inadequate fixation, exacerbation of symptoms, and repeated periods of disability.

Since it is our job to return disabled individuals to industry as rapidly and in as good condition as possible, a therapeutic régime should be employed which would shorten the total disability period, give some assurance against reactivation, and result in a low "disability rating".

Therefore, as the third school, let us employ the following general hygienic measures, plus heliotherapy, using those orthopaedic appliances which are indicated until the optimum conditions obtain for surgical intervention:

1. An improvement of the general condition of the patient,
2. Demonstration of patient's ability to combat the disease,
3. A quiescence of the destructive process in the bone, and
4. A favorable state (quiescence of activity) of other tuberculous foci.

Whether or not all tuberculous joints should be ankylosed is a matter of judgment, depending upon the sex, age, and occupation of the patient. It is certain however that in order to produce a permanent result, *all weight-bearing joints should be ankylosed*, the method of fixation or ankylosis being a matter of choice with the surgeon. While the bone graft is becoming fixed or the arthrodesed joint fusing, the conservative or general therapy is resumed until it is deemed advisable to begin graduated activity,—*i.e.*, until the tuberculous disease is considered inactive or arrested.

In a series of bone cases at Glen Lake Sanatorium treated entirely without surgery the average number of hospital days was 1115, while in a series of cases treated by general therapy *plus surgery* the period of hospitalization was reduced to 682 days. Follow-up records in the first group showed recurrence or reactivation in twenty per cent., occurring within the first two years after discharge, while in the second series, followed from one to three years after operation, the figure was two per cent.

A further series of cases, treated surgically without preliminary observation and allowed up in three to six months, then admitted to Glen Lake Sanatorium with reactivation, slipping bone grafts, or new lesions, required longer periods of hospital care than did the same type of case treated by the régime outlined.

CONCLUSIONS

1. Since tuberculosis is a disease which may involve any part of the body, we must treat the whole individual in the best interests of that individual, no matter in what structure the disease is manifest clinically.

2. Treatment should be governed by the combined abilities of both the orthopaedic surgeon and the specialist in tuberculosis.

3. Proper surgical procedures at the right time, preceded and followed by the more conservative general therapy, afford better and more lasting results than conservative measures alone, or surgery without adequate preoperative observation.

4. Our present therapeutic régime has reduced hospital days from 1115 to 682 and recurrences in the first two years from twenty to two per cent.

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CONGENITAL ABSENCE OF THE ODONTOID PROCESS RESULTING IN DISLOCATION OF THE ATLAS ON THE AXIS

BY SUMNER MEADE ROBERTS, M.D., BOSTON, MASSACHUSETTS

On September 4, 1931, a young man, twenty years of age, came to the emergency ward of the Massachusetts General Hospital complaining of pain in his neck. The onset of symptoms had been sudden and had occurred the day previous when he had been "bridging" in a gymnasium. This meant that, lying on the gymnasium mat face uppermost, he had lifted his body off the mat by arching his back until his weight was supported only by his feet and his hyperextended head. In this position he was slowly moving his feet so that they described a circle with his head as a pivot. He suddenly felt something snap in his neck at the base of his skull and collapsed on the mat with severe pain in his neck. There was no loss of consciousness and no impairment of sensation or function in his extremities. He went home alone, but came to the hospital the next day because the pain in his neck still persisted, though to a lesser degree.

Physical examination showed a well developed and muscular young man who held his head turned about twenty degrees to the right of the mid-line and tipped very slightly to the left. There was moderate tenderness on pressure over the spinous process of the axis and slight tenderness laterally on both sides at the same level. Visual examination of the posterior nasopharynx revealed no abnormality. All neck motions were slightly painful and were limited by muscle spasm. He could not rotate his chin to the left of the mid-line. Other motions were correspondingly restricted. Passive motion of the occiput on the atlas was nearly normal, but all other passive motions were limited by muscle spasm. A diagnosis of a forward dislocation of the left articular facet of the atlas on the axis was made.

The roentgenographic examination confirmed the clinical diagnosis, except that the dislocation was backward on the right, instead of forward on the left, and also revealed the reason for it. The patient had no odontoid process (Fig. 1). The odontoid had apparently failed to develop. The spot where the base of the odontoid normally would be appeared as a smooth ridge with a slight sulcus on either side at the inner margins of the articular processes.

The patient was put to bed on a Bradford frame and five pounds of head traction were applied. Roentgenograms taken three days later showed the dislocation to be reduced (Fig. 2). A molded leather collar was made and fitted and he was discharged from the hospital one month after entry. The question that arose at the time of discharge was: Was this boy constantly in danger of another dislocation, a dislocation which might readily be fatal? The answer was probably in the affirmative. Any trivial injury, such as a sudden unguarded movement, might dislocate an unstable neck of this sort. This danger was explained to the patient and a stabilizing operation advised. Operation was refused, however.

This man was seen again one year later, during which time no untoward accident had occurred. He had not played football, but had played basketball regularly. His neck was symptom-free and all motions were normal. The danger he was running was once more explained to him and operation advised, but he again refused.

SUMMARY

An unusual congenital abnormality, absence of the odontoid process, is described. This deformity resulted in a backward dislocation of the atlas on the axis. The dislocation was reduced, but, without a stabilizing operation, it may readily recur and such a recurrence may conceivably be fatal.

FIG. 1

Dislocation of atlas on axis. Roentgenogram before reduction.

FIG. 2

Roentgenogam after reduction. Congenital absence of the odontoid is clearly shown.

OSTEOPOIKILOSIS

A Case Report

BY HUGH JETER, M.D., AND CHAS. L. McGEHEE, M.D.,
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Surgical Pathological Department, State University Hospital

Cases of "osteopoikilosis" or "osteopathia condensans", apparently a variant of marble bone, have only occasionally been reported. We are able to find only nineteen such cases in the literature and, therefore, consider the following report justifiable.

T. N., white male, aged thirty-seven years, World War veteran, and a welder by occupation, was admitted to the Soldiers' Ward of the University Hospital, September 10, 1932, complaining of a skin eruption. The Dermatological Department made a diagnosis of tinea versicolor and administered appropriate treatment, with satisfactory improvement. The family and previous history were unimportant, except that the patient had had a shrapnel wound of the right shoulder with a resulting slight impairment of function. The roentgenogram of the shoulder revealed particles of shrapnel, and, in addition, scattered, small, dense areas about the metaphysis and epiphysis of the humerus. When a request for the roentgenograms of other bones was made, the patient volunteered the information that the same condition existed fourteen years previously while in service,—physicians had noticed "spots" in his bones, and many pictures had been taken. The patient was permitted to see the films and he considered the condition about the same as in 1918. An attempt was made by the author to look up his service record through the Veterans Bureau but information was refused.

Physical examination revealed no deformities, or abnormalities, except the skin lesions. He appeared hale and hearty. Pulse rate during his hospital period of thirty-eight days ranged slightly higher than normal, temperature normal, and blood pressure 110/65. Three separate specimens of urine were negative. The blood counts were normal; Wassermann and Kline tests, negative. Blood chemistry findings were as follows: non-protein nitrogen, 27 milligrams per 100 cubic centimeters; urea, 13 milligrams; uric acid, 5.6 milligrams; creatinin, 1.3 milligrams; sugar, 84.2 milligrams; blood calcium, 9.9 milligrams; blood phosphorus, 2.7 milligrams; total protein, 10.9 per cent.; albumin, 7.1 per cent.; and globulin, 3.8 per cent. The basal metabolic rate was minus 9.2 per cent.

The roentgenographic examination of the skeletal system showed multiple areas of increased density of bone, most numerous about the metaphyses and in the epiphyses of the bones of the feet, hands, arms, and legs, with a few such areas in the pelvic bones and scapulae. The bones of the spine, ribs, and skull showed no evidence of such changes. The areas of density were somewhat irregular in outline, but roughly round, fairly well circumscribed, and ranged from one-half to ten millimeters in diameter.

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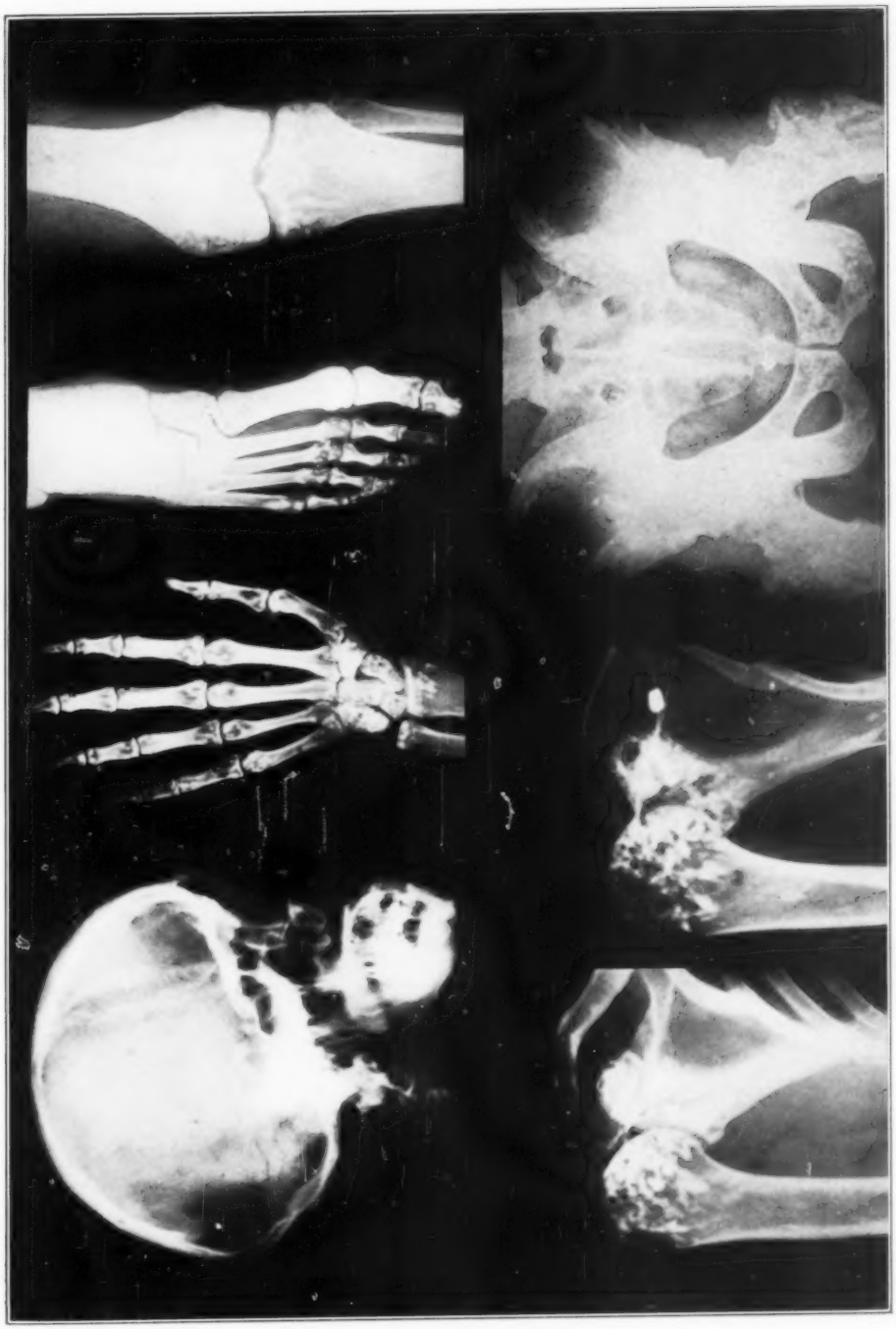

Fig. 1

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THE SMITH-LOWE SPLINT

BY ETHAN H. SMITH, M.D., SAN FRANCISCO, CALIFORNIA

Several years ago the value of the well known Hodgen's splint was demonstrated to the author in a fracture of the lower half of the femur into the knee joint, with three large hematomata on the outer side of the thigh, but difficulty was experienced in preventing toe-drop. In view of this case, as well as later experiences, and with the aid of suggestions from Dr. Frank A. Lowe, this splint has been modified to meet this defect.

The splint as now constructed has two side bars, bent at an angle so as to semiflex the knee, thus relaxing all muscles of the hip, thigh, and lower leg. A half hoop or bail is so set in sliding sleeves that the length may be changed to adapt it to the individual patient. A central bail for support of the side bars and a hinged bail at the top are set into the side bars, and these side bars are inserted into tubular bars, allowing adjustment of the thigh portion to any necessary length. The hinges at the top permit either side to be extended higher than its opposite, so that the top of the outer bar may extend higher than the inner, and may alternate so as to accommodate either the right or the left leg.

By combining traction with suspension, many fractures of the leg may be easily treated by this splint. Skin traction is obtained by means of a moleskin plaster and fulfills all requirements, although skeletal traction may be used if desired. For fractures of the femur, including those of the neck of the femur, traction in two directions is necessary,—one pulling in the direction of the axis of the shaft of the femur, and the other below the foot in the axis of the leg. Pads are inserted between the bars and the leg or thigh to prevent lateral displacement.

The bail below the foot is wound with a bandage to bring the metatarsal region against the sole of the foot, and to prevent toe-drop as well as rotation of the foot.

The splint can be applied without anaesthetic when the patient is reasonable. It also helps to keep the bed sanitary and facilitates the use of the bedpan.

FIG. 1

Case 1. Second fracture before reduction.

FIG. 2

Case 1. Second fracture after reduction.

The trunk can be raised and lowered without disturbing the fracture, thus guarding against pulmonary complications.

CASE REPORTS

CASE 1. Mrs. J. N., aged seventy-nine years. Fracture of the neck of the femur at the junction of the head and neck. Reduction perfect; recovery complete; no anaesthetic. At the age of eighty-two years the patient had a comminuted intertrochanteric fracture of the neck of the same femur (Fig. 1). Reduction, without anaesthetic, excellent, and splint applied. On the twenty-ninth day the patient had a second stroke of apoplexy and died. Pathological specimen of femur showed sufficient union so that fragments could not be moved upon each other by manipulation with the hand (Figs. 3 and 4).

FIG. 3

Case 1. Pathological specimen.

FIG. 4

Case 1. Pathological specimen, lateral view.

FIG. 5

Case 2. Showing application of splint.

CASE 2. G. R., girl, twelve years of age. Both femora fractured at junction of middle and upper thirds; comminuted fracture of neck of the left humerus. Treated by bilateral long spica for five weeks. Right femur united without deformity; non-union and overriding of fragments of left femur; malunion of humerus. After six weeks the patient came under the observation of the writer. Under anaesthesia the left femur was manipulated and the fracture reduced. The splint described was applied, and the patient made an uninterrupted recovery.

CASE 3. Mrs. R. M., aged sixty-two years. Comminuted fracture of neck of the left femur, and fracture within capsule of the joint. Patient a semi-invalid, with bronchial and cardiac disease. Splint applied without anaesthetic; good recovery; slight outward rotation, but no shortening.

CASE 4. Mr. E. L., aged sixty-one years. Struck by automobile and sustained a badly comminuted fracture of the head and three inches of shaft of the left tibia, and comminuted fracture and dislocation of head of left fibula. Splint applied under gas anaesthesia. Convalescence slow because of extent of fracture, but patient recovered with good knee joint,—no deformity and no shortening up to six months.

PSEUDARTHROSIS OF THE TIBIA

A Case Report

BY CLARENCE A. RYAN, M.D., C.M., VANCOUVER, BRITISH COLUMBIA

This report is not offered with the view of adding anything new concerning the etiology or treatment of ununited fractures. The patient's history alone is of interest. The pseudarthrosis was discovered during the routine examination of the patient. His present complaint, a tenosynovitis of the ring finger of the left hand, does not bear any relation to the subject of this report and therefore will not be discussed.

FIG. 1

FIG. 2

Mr. B. cut his finger on a broken bottle in December 1932. Infection occurred and he was admitted to the hospital for treatment. Physical examination was negative except for the infected left hand, the left ankle, and the right lower leg. Examination of the left ankle showed what appeared to be a dislocated astragalus. Roentgenograms, however, did not show a dislocation of the astragalus, but what might be considered a forward displacement of the tarsus on the tibia. Examination of the

right lower leg showed an enlargement of about four inches above the malleoli (Fig. 1). The surface of the skin was elevated about three-eights of an inch above the surrounding skin. The elevation was limited to the surface over the tibia. On palpation, motion could be felt in the tibial shaft. This motion was limited to about three degrees anteroposteriorly and to a lesser extent laterally. Crepitation could be heard on motion. The roentgenogram (Fig. 2) shows a modified ball and socket joint in the tibia. The ends of the bone comprising this joint are well covered by callus, but no attempt at union can be seen. There is an outward bowing of the fibula opposite the pseudarthrosis.

This patient is a cowboy, steer-dodger, and rodeo performer and his injury dates from 1921 when a horse which he was riding fell, throwing Mr. B. under him. Both bones of Mr. B's right leg were broken at the location of the pseudarthrosis, and both apparently healed.

In 1927, while riding in a wild horse race, the patient was again thrown and the same leg was broken in the same place. In this accident, his left ankle was dislocated (?). The fractured bones again healed but the dislocation was not reduced.

In 1929, while competing in a rodeo, he fell and fractured the right leg in the same place as the two former fractures had occurred. The accident occurred at four o'clock in the afternoon. A cast was applied at the hospital and the man returned to the rodeo and re-entered the competition an hour later. The following day he again took part in the round-up, although his right leg was in a cast. Three weeks after the accident, he removed the cast himself and did not consult a doctor until the time of his admittance to the Vancouver General Hospital for treatment of the infected hand, three years after his last fracture.

Mr. B states that he knew there was some motion in his leg at the site of the fracture, but, since it did not hinder him in any way or cause him any discomfort, he did not bother about it. He has continued his steer-dodging and broncho-busting without further injury. The only support to the leg is a high leather boot. His left ankle does not produce any disability, although the foot turns inward when more than ordinary weight or strain is placed upon it.

A review of the 1932 literature yields four references to pseudarthrosis of the leg. Campbell's report[1] is so complete as to etiology, blood chemistry, and treatment that no space will be occupied here with such discussion. No treatment was undertaken in this case since the patient did not wish it.

The author is indebted to Dr. H. H. Boucher for permission to publish this case.

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SEBACEOUS CYST OF THE DISTAL PHALANX

BY FRANK E. CURTIS, M.D., AND CLARENCE I. OWEN, M.D.
DETROIT, MICHIGAN

The following case is reported because of the unusual character of the tumor.

FIG. 1

Anteroposterior roentgenogram before operation.

E. J. S., a male, twenty-nine years of age, was examined in December 1929 for an enlargement of the distal portion of the left mid-finger.

The patient stated that the swelling was first noticed in 1921, when the finger had a constant fever which was particularly noticeable after going into a warm room. He was examined for foci of infection and a tonsillectomy was done. This did not improve the condition of the finger. Later, tincture of iodin was several times injected into the finger, but the phalanx continued to increase in size and a constant, throbbing pain was present. In May 1924 the cyst was excised, but the size of the finger was only slightly reduced and the pain remained. Later, amputation of the finger at the mid-phalanx was advised as it was feared that the condition might become malignant.

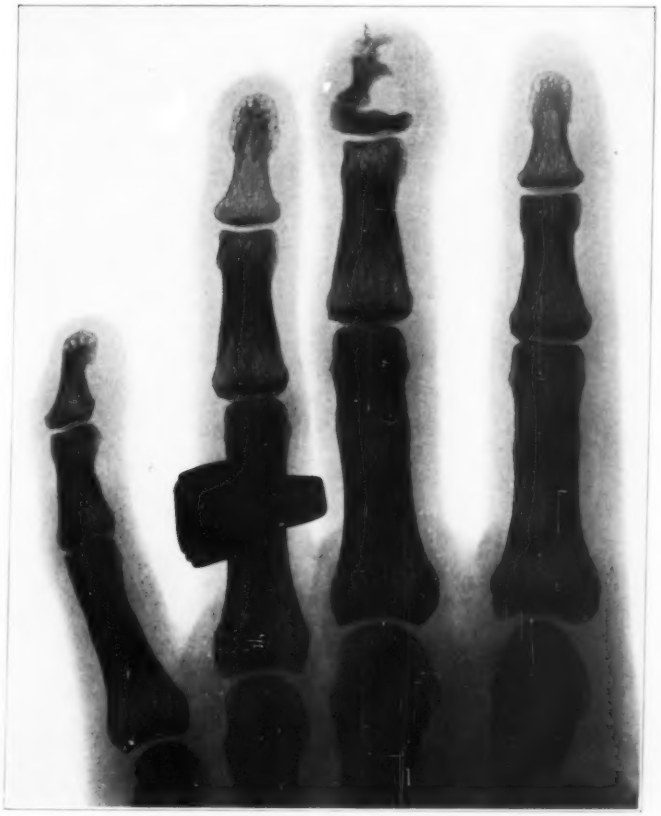

FIG. 2

Anteroposterior roentgenogram after operation.

In December 1929, examination showed the distal portion of the left mid-finger to be nearly twice its normal size and tender to touch. The convexity of the nail was increased. Roentgenograms showed two cystic areas in the terminal phalanx and removal was advised.

At operation the two cystic areas were found embedded in the partially destroyed terminal phalanx. The sacs were adherent to the bone and were of glistening, white, fibrous material inside of which was sebaceous material. The sacs were completely removed. A portion of the distal phalanx and fatty tissue was also removed for diagnostic purposes.

The microscopic examination made by Dr. Owen was as follows: "(1) The pieces of bone exhibit a small amount of callus formation and have attached to them some normal fibrous tissue; (2) the piece of soft tissue is composed of fibrous and areolar tissue and is infiltrated with a few small round and plasma cells; (3) the pieces of cyst wall are composed of markedly flattened, dense, fibrous tissue, relatively non-cellular and having a lining of flattened, stratified squamous epithelium. No glands are found in the wall."

The diagnosis was (1) Epidermoid cyst of the bone; (2) low-grade repair of the bone; (3) low-grade chronic inflammatory reaction of the soft tissue.

In the three and a half years since operation there has been no recurrence of the symptoms and the size of the finger has decreased. Prints of the roentgenograms before and after the operation are shown.

FIG. 3
Lateral view after operation.

This cyst might be classified as epidermoid in nature, as only an epithelial lining was found in the wall, but, as sebaceous material was present in the cysts at operation, this is being reported as a sebaceous cyst. We can find a record of only one other such case, that reported by Dr. R. I. Harris.[1]

It is quite proper to regard this as an implantation tumor, although there is no previous history to support this fact.

1. HARRIS, R. I.: Sebaceous Cyst of Terminal Phalanx of Thumb. An Unusual Form of Bone Tumor. J. Bone and Joint Surg., XII, 647, July 1930.

THE OS EPIPYRAMIS: REPORT OF A CASE

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The os epipyramis is an element found on the dorsum of the hand between the lunate, triangular, and hamate bones. Dwight[2] says it is "a very rare bone. . . . It would naturally be mistaken for a fracture. Usually no trace of this element is to be found, but it may appear as a marking off of the dorsal distal radial angle of the cuneiform. . . . I have seen one case; but a doubtful one." It has been found as a separate bone in the human wrist by:

1. Pfitzner, once; specimen.
2. Dwight, once; specimen; doubtful example.
3. Grumbach, three times; roentgenograms; two of these are not clearly separate entities.
4. Heimerzheim, once; roentgenogram; apparently an excellent example, but a tracing — not the roentgenogram — is reproduced.

This bone was not encountered by Pirie or Bogart in their studies of the accessory bones of the wrist.

The present case is reported because of the rarity of this bone and because it seems to be a clearer roentgenographic example than the cases noted above.

The patient is a boy, aged fifteen, with a fracture in the distal third of the left radius and ulna. The epipyramis is two millimeters in diameter, oval in shape, and situated in

FIG. 1

the space between the left lunate, triangular, and hamate bones. It is well formed and there is no evidence of traumatism in its region.

Dwight's statement that this bone would naturally be mistaken for fracture seems unwarranted, as this is not a region where fracture is apt to be found unless traumatism is very extensive.

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RUPTURE OF THE LONG HEAD OF THE BICEPS BRACHII

BY J. O. RANKIN, M.D., F.A.C.S., WHEELING, WEST VIRGINIA

From the Department of Surgery, Wheeling Clinic

Rupture of the long head of the biceps tendon is a comparatively unusual injury. In 1927 McKenna found eighty-one cases reported in the literature. To this number he added one case. A search of the literature since that time has revealed less than ten additional case reports. Most of these were described in foreign reports. Of the eighty-one cases that McKenna reported, only fifteen had gone to operation. The writer desires to report four additional cases, two of which came to operation and two in which operation was refused.

CASE REPORTS

CASE 1. H. S., a white male, fifty-eight years of age, complained of pain in the right upper arm and inability to use the arm normally. He gave a history that two hours before examination, on January 14, 1930, he was helping some fellow workmen to lift a heavy metal vat with a bar, while at work in a foundry. He suddenly experienced a sharp pain in the region of the right shoulder and his arm seemed to "give way". Following this any attempted motion induced pain in this region. His past history revealed that he had always worked regularly and that he never had had any serious illness or injury.

Physical examination was negative except for the findings in the right arm. The first thing noticed on the arm was a peculiar spheroidal swelling just above the elbow joint anteriorly. This was intensified when the patient flexed the forearm. All motions could be carried out, but flexion and supination of the forearm induced severe pain. There was no evidence of subcutaneous ecchymosis. The most tender areas were just below the coracoid process and at the upper margin of the enlarged area in the lower arm. The forearm was normal.

Roentgenograms of the shoulder were negative. Blood Wassermann and urinalysis were negative.

A diagnosis of rupture of the long head of the biceps tendon was made and the patient was sent to the hospital for operation.

Operation:

Tenoplasty, July 15, 1930. A longitudinal incision was made over the upper end of the belly of the muscle, in the anteromedial portion of the arm. When the deep fascia was opened, the tendon was found coiled up against the belly of the muscle. The end showed evidence of a recent rupture but was apparently normal otherwise. About one inch of the proximal end of the tendon was found protruding through the bicipital groove. The forearm was flexed and the ends sutured with interrupted chromic catgut.

The patient made an uneventful recovery and returned to his employment on September 15, 1930. He has had no further trouble.

CASE 2. C. O., a white male, American, aged sixty-five years, complained of pain in the left upper arm, and inability to move the arm. He gave a history that, on the preceding afternoon, March 10, 1932, while lifting and pushing on a heavy fly wheel in a steel mill, he felt a sudden snap in the shoulder, which was followed by inability to move his arm in any direction without experiencing severe pain. The past history revealed that he had been a steel-mill worker for years. His family physician stated that he had had some arthritis in his shoulder joints.

Physical examination was negative except for some crepitation in the right shoulder joint and the injury in the left arm. The patient carried his arm very carefully in the flexed position. The typical spheroidal lump was seen just above the elbow joint anteriorly. It was intensified when further flexion was attempted. All motions of the shoulder joint produced pain, as did supination of the forearm. No ecchymosis was observed.

Roentgenograms revealed considerable hypertrophic osteo-arthritis around the edges of the glenoid fossa and at the acromioclavicular joint. Blood Wassermann and urinalysis were negative.

A diagnosis of rupture of the long head of the biceps tendon and osteo-arthritis of the shoulder joint was made.

Operation:

Tenoplasty, March 11, 1932. A long incision was made from just below the coracoid process down to the upper margin of the belly of the biceps muscle. The deep fascia was opened and the tendon was found coiled up against the proximal end of the muscle. The end was somewhat frayed. The proximal end could not be observed, as the rupture had occurred in the bicipital groove. As an end-to-end anastomosis was impossible, the end of the distal fragment was sutured to the origin of the short head with chromic catgut.

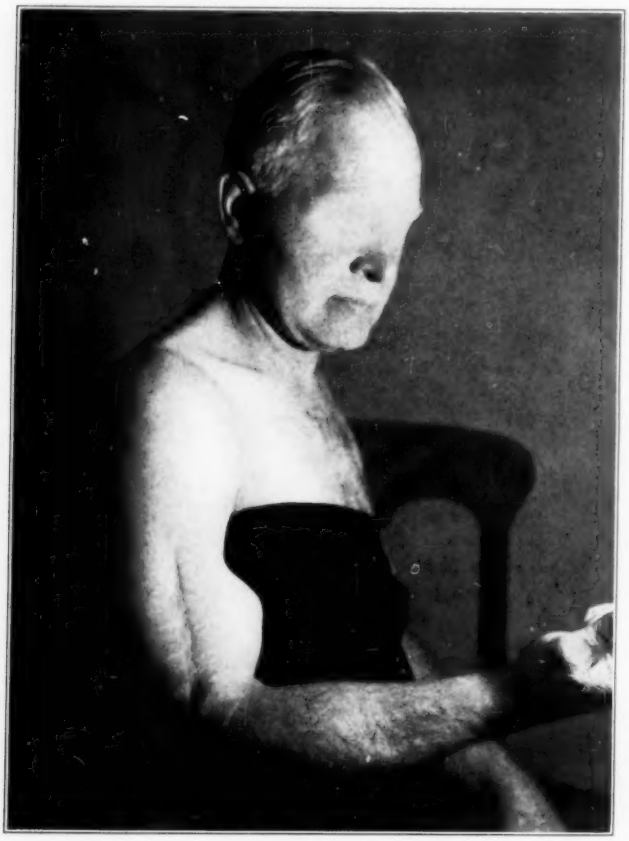

FIG. 1

Typical spherical deformity of belly of the biceps muscle after rupture of long head of the tendon.

The patient's convalescence was perfectly normal except for some pain in the arthritic joint, which required physiotherapy. He returned to his work two months after the operation and has been completely well since that time.

CASE 3. F. S., a white male, forty years old, complained of pain in the region of the right shoulder joint. On November 20, 1931, the day before he came to the Clinic, he was cranking a car. During the act of pulling up on the crank, the motor back-fired, jerking his arm out in extension before he could let go of the crank. Simultaneously he felt a sudden sharp, severe pain in the shoulder, followed by inability to move the arm without experiencing pain. His past history was irrelevant to the present illness.

The patient was carrying his arm in the sling his family physician had applied, which he stated was the most comfortable position. The typical spheroidal or bulbous swelling was noted above and anterior to the elbow joint and was intensified when further flexion was attempted. Marked tenderness was elicited over the bicipital groove and at the upper end of the muscle. Forced flexion and supination were exquisitely painful. All motions of the shoulder joint were normal. X-ray examination was not made.

The diagnosis was rupture of the long head of the biceps tendon. Operation was advised, but the patient refused to cooperate.

Recently the patient reported that he is free from pain and that, except for weakness upon flexion of the forearm, he has no untoward symptoms. The deformity in the lower arm has persisted. It is probable that eventually he will have practically normal power of flexion.

Case 4. H. R., a white male, forty years of age, complained of a painful and swollen right arm upon admission to the hospital on July 11, 1924. On the morning of that day, he had been plowing with a tractor. While pulling up a steep hill, the tractor reared up and fell back on the patient, pinning him beneath it. The right arm was crushed.

X-ray examination revealed an oblique fracture of the humerus in the middle third, with marked displacement of the fragments. There was a large amount of swelling.

The arm was reduced as much as possible and packed in ice. Three days later a paralysis in the distribution of the radial nerve was noted. This, of course, necessitated open reduction and exploration of the radial nerve.

The wound healed by primary union and the fracture healed in three months. By this time all evidence of paralysis had disappeared. After all dressings were removed and motion started, it was discovered that the patient had the typical bulbous swelling of a rupture of the long head of the biceps tendon.

Repair of the tendon was advised, but the patient declined any further operative procedure. He has been examined at frequent intervals since the accident. The power of flexion has increased gradually until, at the present time, it is practically normal. The muscle has attached itself in the lower third of the humerus and has increased in size to compensate for the shortening, so that upon flexion it now stands out almost twice as far as the corresponding muscle of the left arm. At the end of a year all motions were normal and none produced pain. The normal strength of flexion, however, did not return for five years. Of course, a part of this delay in the return of normal function may have been induced by the fracture.

DISCUSSION

In all four of the cases reported, the patients gave a very definite history of trauma. Two were lifting very heavy objects, the third had his forearm suddenly jerked into extension while carrying out a flexion motion, and the fourth case was the result of direct trauma. In the case where rupture occurred in the bicipital groove there was evidence of some degenerative changes in the tendon, a result of the preexisting arthritis in the shoulder joint. Although a section was not removed for microscopic study, it certainly did not appear normal macroscopically.

All had the typical bulbous enlargement of the belly of the biceps muscle, which was considerably lower than the belly of the muscle on the opposite side. Pain was noted when flexion or supination was attempted and there was tenderness in the upper margin of the muscle.

The two patients who were operated upon made an uneventful recovery and returned to work. One of the two who were not operated

upon was observed for several years and now has about seventy-five per cent. return of function, although the deformity remains.

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A SIMPLE METHOD FOR MAKING PLASTER CASTS OF FEET

BY EDWARD N. REED, M.D., SANTA MONICA, CALIFORNIA

For the making of accurately fitting arch supports, a plaster cast of the foot is necessary. The old method was to fill a pan with thick plaster cream, set the foot in this until the cream hardened, thereby securing a "negative", then to grease the negative and fill it with plaster cream, and, finally, to break off the outside mold, leaving an exact model of the foot in plaster-of-Paris.

A more rapid, simple, and less "mussy" method is the following:

Take a "hard-coated" plaster bandage, four, five, or six inches wide, depending on the height to which one wishes to carry the model up on the sides of the foot,—four inches for the "Boston" or the "spoon" type of plate, five or six inches if a "Whitman" type of plate is to be made. Cut from this bandage four lengths of the foot in question and lay them one on top of the other, as in making a molded splint. Powder the foot, dip the molded splint in water for a moment, lay it on the bottom of the foot, and rub it thoroughly against the foot while it is setting. The "fast" plaster will set in five or six minutes and can then be easily removed. We now have a thin shell model of the foot, which is both a positive and a negative.

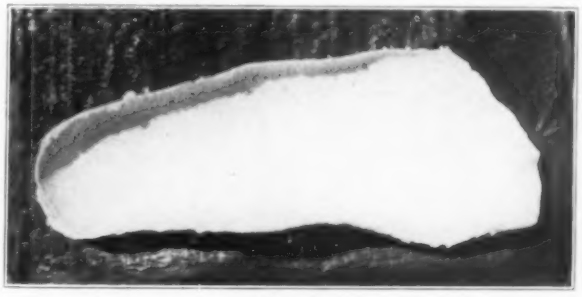

FIG. 1

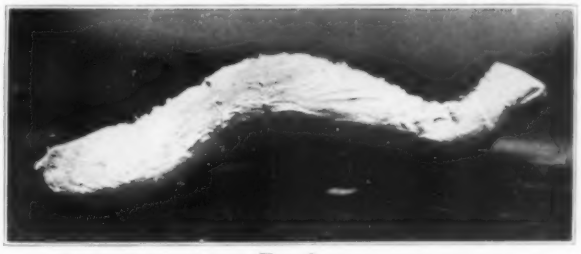

FIG. 2

To be sure, if used as a positive, it is a little larger than the actual foot, by reason of its one-eighth-inch thickness. But this thickness of the mold is just about equal to the thickness of the leather covering of the finished support, plus the stocking of the wearer, so that the metal fitted over this cast will bear a correct relation to the foot when covered.

These models do not permit of "carving" before being sent to the plate-maker; but we have found that, if the cast is made with the foot held in corrected position, the plate will carry all the correction the wearer can stand, at least to begin with.

LOOSE BODIES IN THE ELBOW JOINT

An Unusual Location and Form

BY RODNEY F. ATSATT, M.D., SANTA BARBARA, CALIFORNIA

CASE REPORT

A male, aged twenty-two, was first seen on April 7, 1932, when he reported because "there was a loose piece" in his right elbow joint. He gave a history of injury during the previous football season, followed by a period of swelling and pain in the elbow. The pain, however, was not so severe as to cause much difficulty in ordinary use. When the swelling subsided, there was noticeable over the region of the radiohumeral joint a small mass half the size of a marble, which was freely movable within restricted limits. There was no history of locking or discomfort following the original injury.

Roentgenographic examination disclosed a loose body, one by one-half centimeter in size, lying adjacent to the lateral epicondyle. There was also, however, an unusual spherical, laminated shadow of bone density, one centimeter in diameter, in the supratrochlear fossa, lying in a rounded notch, but apparently unattached (Figs. 1 and 2).

Prediction was made that at some future date the radial body would cause locking, and it did so on December 2, 1932, as shown in Figures 3 and 4. The patient presented himself with a locked elbow in 120 degrees of flexion. He consented to an operation and both bodies were removed. An uneventful convalescence ensued, with full return of function.

DISCUSSION

Interest naturally centers on the spherical bone mass above the olecranon. This probably represents a small chip or bone from the tip of the olecranon, which has been constantly rolled over and over by a tangential impulse provided by the normal extension of the elbow. It

FIG. 1

FIG. 2

FIG. 3

FIG. 4

has thus grown into a perfect spherical form. Interestingly enough, at some time between the taking of Figures 2 and 4, this bone mass has been squeezed between the olecranon and the edge of the fossa with sufficient force to cause an eruptive fracture such as one would obtain by compressing a ripe orange.

The operative procedure was simple, but the case is reported because of the unique form and location of the supratrochlear loose body.

A PROBABLE BIRTH FRACTURE OF THE NECK OF THE FEMUR

BY C. F. EIKENBARY, M.D., F.A.C.S., AND JOHN F. LECOCQ, M.D.

SEATTLE, WASHINGTON

The following case is reported because of its extreme rarity.

A. S., aged eleven, came under our care because of a marked waddling gait which had been present from the time she began to walk. Outside of the fact that the peculiar waddling gait had been present from about the age of fifteen months, the history was entirely negative.

The examination showed that she was a very well developed girl, with two inches of shortening of the lower extremity. Her gait was quite typical of the unilateral, congenital dislocation of the hip. The head of the femur could not be felt, but, regardless of this, we felt that we were dealing with the usual case of unilateral dislocation. The roentgenogram, however, disclosed an extreme degree of coxa vara, as shown in Figure 1. After the roentgenogram had been taken, the mother produced another which had been taken six years earlier, when the child was five years old. This disclosed the condition shown in Figure 2. This picture certainly indicates an old fracture of the neck of the femur, which has partially healed, with a marked upward displacement of the shaft. The question immediately arises as to when this fracture occurred. There is no history of any trauma that could be responsible. The waddling gait,—that is, the unilateral

FIG. 1

A. S., aged eleven. Marked coxa vara as result of old fracture of the neck of the femur.

FIG. 2

A. S., aged five. Old fracture of the neck of the femur. Fracture evidently occurred at birth.

limp, had been present from the time the child began to walk. We must, therefore, assume that the fracture occurred some time before she was fifteen months of age. There was no trauma during this period, so we are practically forced to assume that the fracture occurred at birth. Intra-uterine fracture may be possible, but certainly not likely.

A cuneiform osteotomy was performed, with the result indicated in Figure 3. The child is greatly improved, but still has some of the waddling gait.

FIG. 3

A. S. Result following cuneiform osteotomy.

We have made a rather extensive search through medical literature to find reports of similar cases. At the time this report was written we had found none, and our investigation led us to conclude that this was the only such case on record. Since writing this account, however, we have been privileged to see a report by Dr. Zadek of New York City, who is recording a series of cases which are somewhat similar to this and which he is describing under the head of "Congenital Coxa Vara". It is quite possible that this case falls in the same category as those reported by Dr. Zadek. However, in looking at the roentgenograms of the case which we are reporting, it seems to us that the appearance is that of an old fracture of the neck of the femur. Certainly Figure 2, the roentgenogram taken when the child was five years old, would seem to indicate that there had been a complete separation through the neck, with the formation of much new bone below the neck and extending down the shaft. While it is possible that we are entirely mistaken in regard to the actual diagnosis here, we feel that the case is of sufficient interest to warrant its report.

ACUTE OSTEOMYELITIS OF THE PATELLA

BY FREDERICK CHRISTOPHER, M.D., F.A.C.S., EVANSTON, ILLINOIS
Associate Professor of Surgery, Northwestern University Medical School; Chief Surgeon, Evanston Hospital

Acute osteomyelitis of the patella is exceedingly uncommon. In an original thesis from Toulouse in 1914, Chalaby [1] collected twenty-two cases from the literature. In 1917, apparently without knowledge of Chalaby's paper, Walther [2] reviewed ten cases from the literature and added two of his own from Lexer's clinic. Previously Röpke [3] had reported two cases from Jena during the period 1889 to 1904. In the case reported by Johansson [4] in 1919, the diagnosis eventually was made by x-ray and the patella was excised. In 1921, Mumford [5] reported a case which finally healed after sequestration.

The following case report is of interest because of the complicating suppurative arthritis.

W. deP., aged eight years, was admitted to the Evanston Hospital on June 23, 1932, following an automobile accident. At operation a ruptured spleen was removed; the convalescence was complicated by a double bronchopneumonia.

At the time of this accident an insignificant abrasion of the left knee was sustained. The knee gave the child occasional pain and there was swelling and limping during the summer. There was tenderness on palpation. X-ray of the knee was negative.

On September 29, 1932, a sequestrum, five-tenths by five-tenths by one-tenth centimeter, was removed from the wound.

On October 3, 1932, the joint was aspirated and a small draining sinus was curetted, but it did not heal. Culture of the joint showed staphylococcus albus.

On December 14, 1932, the sinus was opened up widely and a considerable necrotic portion of the patella was removed. During this operation the knee joint was invaded through the posterior wall of the patella. The leg was immobilized in a cast, and soon afterward walking was resumed and the boy seemed to be getting along nicely.

On January 1, 1933, the knee began to swell and become painful and the temperature rose to 102 degrees.

The patient was admitted to the Evanston Hospital on January 3, 1933. The following day necrotic and infected bone was curetted from the left patella. An opening in the patella, one-half inch in diameter, communicated directly with the knee joint, from which escaped a large quantity of purulent fluid. The joint was irrigated with hot saline containing mercurochrome and the opening drained by Penrose tubing. The following day an arthrotomy of the left knee joint was done. Two long incisions into the joint were made on each side of the patella. Considerable pus and grayish plaques of fibrinous exudate were encountered in the joint. Cultures showed hemolytic streptococcus. The joint was again irrigated with hot saline containing mercurochrome and the edges of the synovial membrane were tacked over toward the skin edges to insure drainage. The leg was placed in a Thomas splint with four pounds of traction.

The patient's course in the hospital was a stormy one, with a high septic temperature, a progressive secondary anaemia, and a marked amount of purulent drainage from the affected joint. The temperature frequently reached 104 degrees with wide septic swings. The pulse ranged between 120 and 180 for a great part of the time. The hemoglobin dropped from 71 per cent. to 47 per cent. on January 24, 1933, when the red blood count

was 2,740,000. On January 6, 1933, the white blood count reached 46,600. The wound formed a large excess of granulation tissue.

On January 20, 1933, under avertin anaesthesia, the leg was placed in a plaster cast with an opening at the knee for drainage. A whole blood transfusion of 350 cubic centimeters of blood was given on January 25, 1933, by the Scannell method.

Four weeks after admission, the patient was discharged from the hospital improved but still running some fever. The boy's general condition improved at home and he started walking. The cast was removed on March 15, 1933. On May 25, 1933, there was considerable motion in the knee joint, some swelling, and no pain. The boy walked with a slight limp and was greatly improved in general health. The wounds were practically healed. The x-ray examination showed some rarefaction and destruction of the patella, but the general contour was very satisfactory. On August 20, the function was 85 to 90 per cent. of normal.

FIG. 1

Acute osteomyelitis of the patella, appearing six months after initial injury.

The diagnosis of acute osteomyelitis of the patella is not always made. In the uncomplicated cases, without involvement of the knee joint, tenderness to pressure localized over the patella will be found. There may or may not have been a previous local skin injury. Johansson[4] points out as characteristic that "the knee is held in the extended position and that there is no indirect tenderness to pressure in the longitudinal direction of the leg". This author further states: "If, as is mostly the case, perforation takes place extra-articularly, the case will appear as a prepatellar-bursitis". In the more advanced cases x-ray examination will be of value.

Where the joint has become involved, the symptoms of the suppurative arthritis will predominate.

The treatment of uncomplicated cases consists of curetting away the infected bone, taking care not to open the joint. Spontaneous sequestration may occur. Where there is a suppurative arthritis a radical arthrotomy should be practised. Johansson[4] advised total extirpation of the patella in these cases. This latter procedure is also employed in chronic, healed cases where there is marked limitation of motion.

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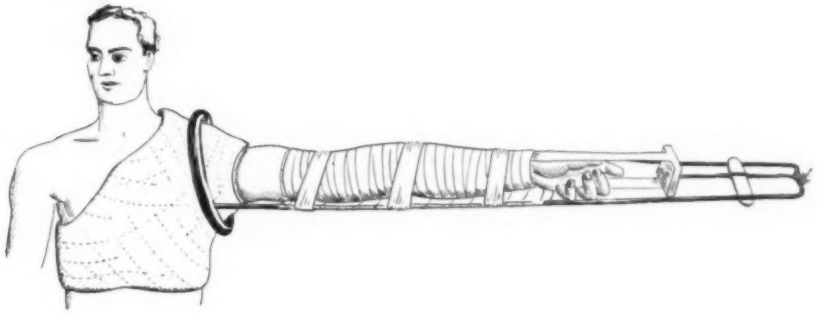
A PLASTER-OF-PARIS BUTTRESS FOR USE IN CASES OF FRACTURE OF THE HUMERUS TREATED BY MEANS OF TRACTION IN A THOMAS SPLINT *

BY JOSEPH B. STENBUCK, M.D., F.A.C.S., NEW YORK, N. Y.

Treatment of fracture of the humerus by means of traction in a Thomas splint is a routine procedure in Harlem Hospital at the present time. Departure from this routine, except for fractures in the vicinity of the elbow joint, is rare. With this simple apparatus, overriding of fragments is corrected by traction increased by means of a Spanish windlass mechanism. Lateral and anteroposterior displacements of fragments or bowing may be corrected by means of a bandage attached to the iron bars of the splint and a pull or support applied in the necessary direction.



In a study[1] of 107 cases of fracture of the humerus, treated in Harlem Hospital from June 1, 1930 to June 1, 1932, several advantages of this type of treatment have been demonstrated. The application and maintenance of the Thomas splint is simpler and easier than that of balanced traction, and the cost of the apparatus is less. After application of the Thomas splint, the patient may be ambulatory immediately and will need very little nursing care. After discharge from the hospital, the patients who had been treated with the Thomas splint had earlier union and better immediate function than those treated with balanced traction. Although the length of stay in the hospital was approximately the same, those treated with balanced traction not infrequently required further splinting when removed from the apparatus, while the others never required any splinting.

We have, however, encountered one disadvantage in treatment with the Thomas splint. Great tension is sometimes required in order to reduce overriding fragments of bone and to maintain them in position. As a result of this marked tension, a feeling of great pressure or of pain

* From the Surgical Service, Harlem Hospital, J. F. Connors, M.D., Director.

may be experienced in the axilla by some patients. Occasionally, in spite of padding, the skin may be irritated and may even slough.

In order to avoid these untoward symptoms, we have devised a plaster-of-Paris buttress to distribute diffusely the pressure of the ring against the axilla and the chest wall. The parts are well padded and plaster-of-Paris bandages are applied as indicated in the diagram. On the arm, the plaster reaches as far as the attachment of the deltoid muscle. Originally it was our intention to incorporate the ring of the Thomas splint in the plaster-of-Paris, but we have followed the suggestion of Ira Fink and apply the ring to the outside of the plaster buttress.

When the use of the Thomas splint produced pain, irritation of the skin, or sloughing, the patients were relieved of these symptoms by the application of the buttress. If it is properly applied, there is no more discomfort than might be expected from the use of the ordinary plaster-of-Paris jacket.

SUMMARY

The Thomas splint, with traction by means of a simple Spanish windlass mechanism, affords a simple, efficient, and economical method of treatment for fracture of the humerus. There is occasionally, however, the disadvantage of too great a localized pressure against the chest wall with accompanying pain and skin necrosis. This disadvantage may be overcome by the application of a plaster-of-Paris buttress (which is a modified jacket), allowing for the diffuse distribution of pressure of the ring of the Thomas splint and the resultant relief of pain.

1. To be published by J. F. Connors and M. S. O'Shea.

A ZIPPER ATTACHMENT TO MUSLIN RETRACTOR FOR TREATING FRACTURES OF THE FEMUR IN CHILDREN

BY H. EARLE CONWELL, M.D., F.A.C.S., FAIRFIELD, ALABAMA

Orthopaedic Clinic, Employees' Hospital

In an article written by the author entitled "Acute Fractures of the Femur in Children" (*The Journal of Bone and Joint Surgery*, XI, 606, Fig. 10, July 1929), an original muslin countertraction apparatus was described. This retractor was applied across the patient's lower abdomen and pelvis, fitting snugly around the buttocks and upper end of the thighs, with the lower part of the retractor extending down below the patient's body for attachment to the bed. The changing and adjustments were made by lacing the lower part of the retractor up to the posterior surfaces of the thighs and buttocks.

The procedure of lacing has been improved by applying zippers, trademarked S-2-C (new) Separating Talon Fasteners, which completely separate. The zippers (Fig. 1) enable the lower part of the muslin retractor to divide all the way to the buttocks and thighs, thus making it possible for the retractor to be removed from the patient in the same way as with the lacing method. This has simplified the nursing of these cases,—the retractor has been made firmer and more stable, time is saved in applying the retractor, and the patient is thereby caused less annoyance.

FIG. 1

Retractor with zippers applied. Note that zippers separate completely, enabling lower part of muslin retractor to be removed entirely from around buttocks and upper part of thighs.

FRACTURES OF THE TIBIA AND FIBULA

A Handy Bar Useful in the Non-Operative Treatment

BY VOIGT MOONEY, M.D., PITTSBURGH, PENNSYLVANIA

The bar which is shown below has been used by the author for several years in the non-operative treatment of fractures of the shafts of the tibia and fibula.

This bar is made of metal tubing and separated in the middle. It is

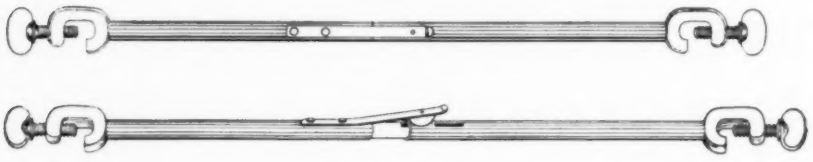


FIG. 1

The bar before and after separation. Note the lock.

of one standard size, and vertical stirrups of all operating and examining tables can be adjusted to meet it. Figures 2 and 3 illustrate its application.

In reducing a fracture of the leg, a plaster-of-Paris cast is applied in two sections (Fig. 3), the knee being flexed so as to relax the calf muscles. The bar fixes the flexed knee in position. Before section No. 1 is applied, felt pads are put on the dorsum of the foot and over the tendo achillis.

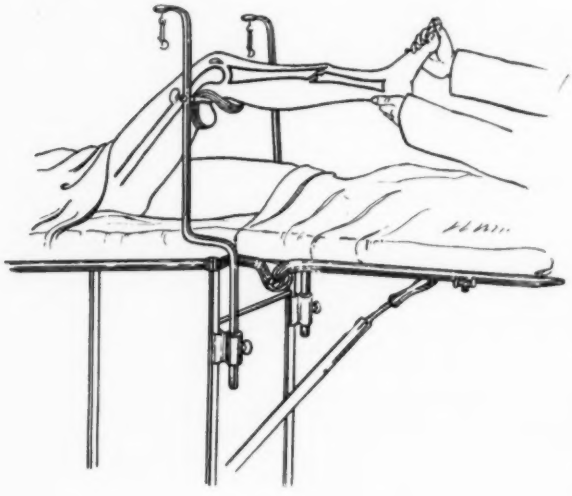


FIG. 2

The popliteal space rests on the bar which is attached to the standard stirrups of any operating or examining table.

While an assistant produces traction, the operator manipulates the overriding fragments and reduces the fracture. The two sections are then joined by means of a cuff of plaster. After the cast has been completed, trimmed, and split, the bar is released at the ends and divided by lifting the key; either half

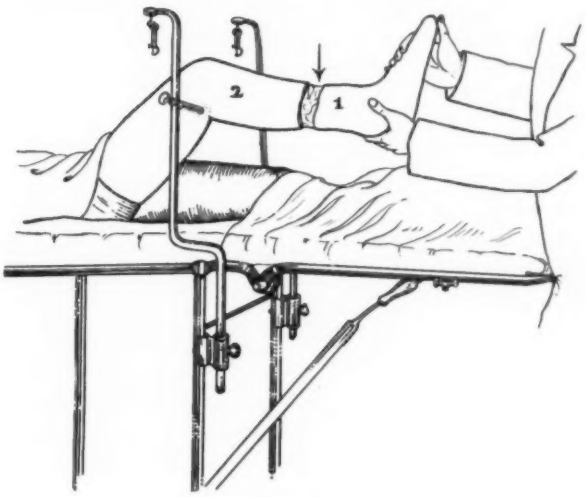


FIG. 3

Showing method of reduction of fracture of the leg.

FIG. 4

Patient about on crutches. Note the hole in the cast through which the bar passed.

of the bar is then pulled out of the cast.

The use of this bar has contributed to the ease with which the non-operative treatment of the fractures of the bones of the leg is carried out. Closed reductions are less difficult and fewer attendants are required in the operating room.

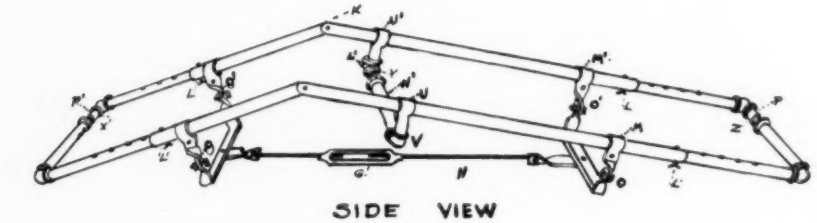
A FURTHER MODIFICATION OF THE CONVEX ADJUSTABLE BRADFORD FRAME

BY B. S. LESTER, M.D., C. H. FORD, M.D., AND THOS. PURSER, JR., M.D.,
BIRMINGHAM, ALABAMA

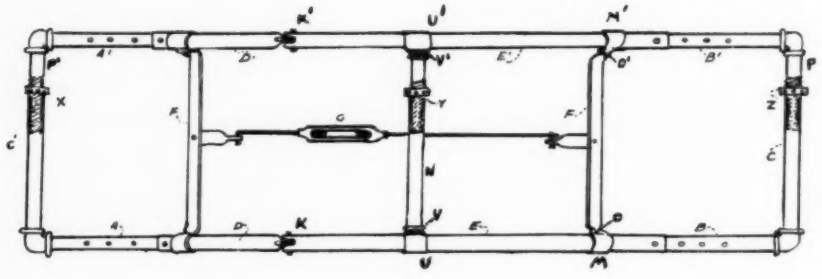
The convex adjustable Bradford frame, as originally described by Herzmark[1] and later modified by Conwell[2], has been used extensively and with excellent results in the care of anterior compressed fractures of the spinal vertebrae, and satisfactory hyperextension of the spine has usually been obtained. In the authors' experience, the main source of irritation to the surgeon and to the other hospital attendants, as well as to the patient, has been the difficulty of keeping the canvas taut because of its tendency to sag under the constantly maintained weight of the patient.

Another change in the structure of the frame is here presented which satisfactorily eliminates this difficulty. It consists simply of the arrangement whereby the width of the pipe frame may be regulated at will, thereby altering at the same time the tension of the canvas.

Sketches in the figures show the following, quoted in part from Conwell's description: "*A* and *A'* and *B* and *B'* show solid iron rods 0.9375 inch by 14 inches long, which are held in place by the four 0.75-inch elbows, which are attached to *C* and *C'''* and to *P* and *P'* (Figs. 1 and 2). "The iron rods have through and through holes placed 2 inches apart, commencing 4 inches from the elbows. The iron rods fit within the 1-inch



SIDE VIEW



TOP VIEW

FIG. 1

pipes shown as D and D' and E and E', and allow for adjustments. The pipes and iron rods are held in place by bolts and wing nuts as shown in L and L' (side view). These winged bolts are 0.25 inch by 1.5 inch.

"E and E' are 40 inches long, and make a lock joint with D and D'" at K and K'. "This lock joint prevents the frame from overflexing. E and E' also receive the iron rods B and B'. D and D', which make up part of the head of the frame, are 16.5 inches long, which connect with E and E' by the lock joint . . . and also allow for the reception of the solid iron bars A and A'."

C and C' are one-inch iron pipes, eighteen inches long, which are connected to B and A at the elbows and which receive at Z and X the threaded ends of pipes P and P'. Knurled and threaded bolts Z and X, screwed on the threads of P and P', cause increase of the distance between B and B' and between A and A' when rotated counter-clockwise (Figs. 1 and 2).

Another supporting piece, N (Figs. 1 and 3), which has incorporated within it Y, a connection similar to Z and X, is attached to E between K and M and to E' between K' and M' by sliding sleeve joints U and U'. This may be moved along E and E' to any desired position before application of the canvas. By incorporation of the elbows V and V', N is dropped below the level of the canvas covering, lends additional support, prevents sagging of the sides of the frame toward each other, and also renders aid in keeping the canvas stretched at the point of the patient's greatest weight.

The iron bands F and F' are attached by bolted connections O and O' (Fig. 1—side view) to M and M' and allow for increase in the width of the frame at these points. G is the turnbuckle which is arranged similarly to those described by Herzmark and by Conwell, and allows for the hyperextension.

The entire frame may be easily and conveniently suspended from the hospital bed by means of four supporting hooks (Fig. 4), made of flexible steel straps, one inch by twenty-five hundredths of an inch, and bent as shown in the sketch. Two of these hooks

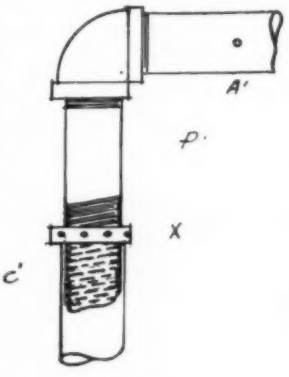


FIG. 2

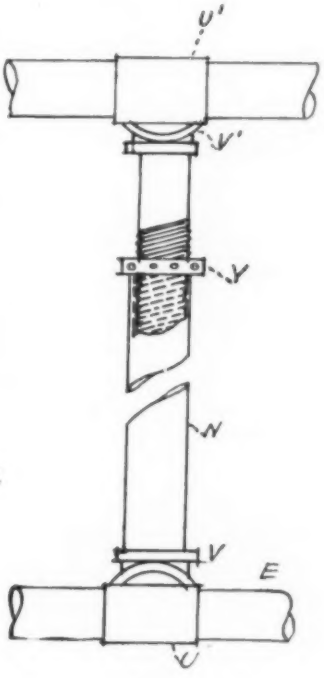


FIG. 3

hang from the head of the bed and two from the foot, those at the head being longer because of the extra height of that part of the bed.

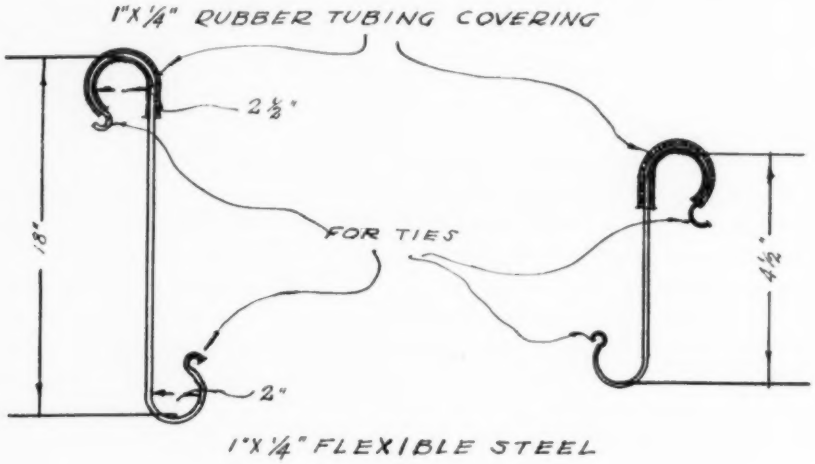


FIG. 4

The portion of the curve of each hook which fits over the bed is covered with one-inch by twenty-five hundredths of an inch rubber tubing to protect the enamel against scratching. Each end of each strap is bent so that light rope or cord ties may be used to give added security if desired, though this is usually not necessary.

The only advantage claimed for this frame is the feature of easy regulation of its width and of the tension of the canvas.

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A FOOT EXAMINING STAND

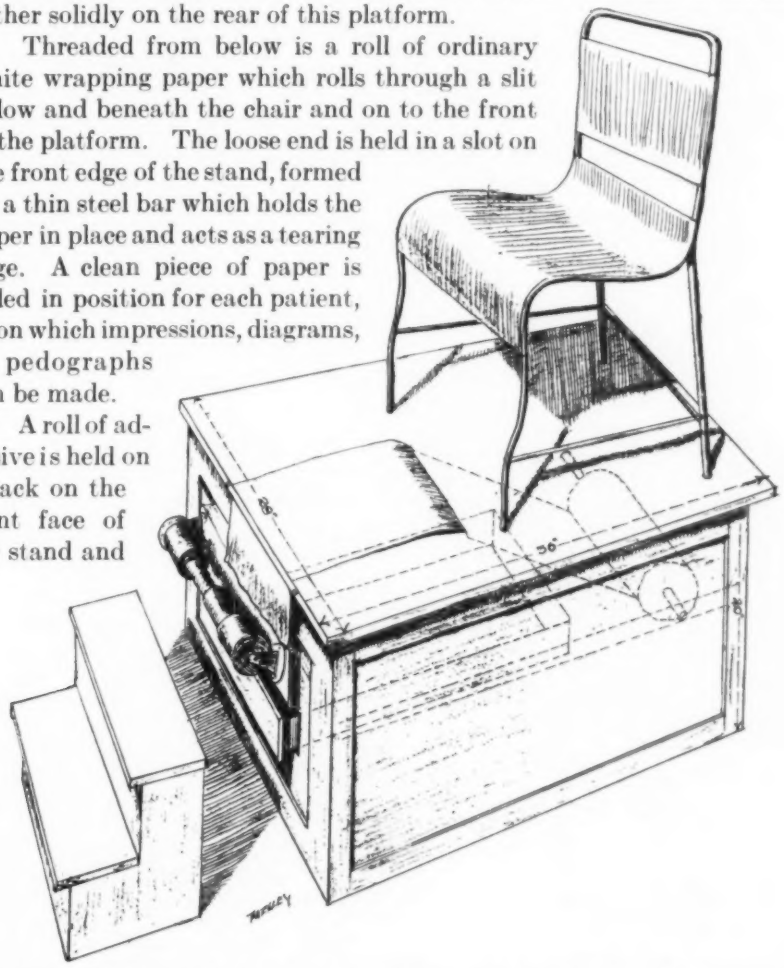
BY REX L. DIVELEY, M.D., KANSAS CITY, MISSOURI

It was found unsatisfactory to examine feet when the patient and examiner were on the same floor level; therefore, the following described stand was devised and has proved most satisfactory.

The examining stand or platform is some three feet square and twenty inches high, built of solid one-inch construction. A chair is mounted rather solidly on the rear of this platform.

Threaded from below is a roll of ordinary white wrapping paper which rolls through a slit below and beneath the chair and on to the front of the platform. The loose end is held in a slot on the front edge of the stand, formed by a thin steel bar which holds the paper in place and acts as a tearing edge. A clean piece of paper is rolled in position for each patient, upon which impressions, diagrams, or pedographs can be made.

A roll of adhesive is held on a rack on the front face of the stand and



a drawer just beneath this rack contains small instruments, measuring devices, etc. A combination step and seat allows the patient to mount the examining stand and also serves the examiner as a seat. This brings the level of the feet with that of the eye of the examiner when he is seated.

The rear or bottom of the platform is left open to allow replacement of a new roll of paper.

A NEW KNEE BRACE

BY HARRY W. WOODWARD, M.D., COLORADO SPRINGS, COLORADO

The only excuse for the presentation to the profession of a new brace must be that it has distinct advantages over apparatus already in general use.

The usual types of knee braces have not proven entirely satisfactory as they do not have enough rigidity to prevent further injury, due especially to lateral blows or twists.

The brace illustrated below has the usual leather cuffs above and below the knee and the two hinged lateral bars. In addition, it has a third posterior, metal, hinged bar which increases its stability and effectiveness to a marked degree (Fig. 1). This posterior bar works through a hinged metal tunnel which allows the brace to flex easily and still lose none of its stability (Fig. 2).

The addition of this posterior bar gives an absolutely rigid brace laterally, and still does not interfere with flexion and extension of the knee (Figs. 3 and 4).

In addition to this posterior hinged bar, the only difference from the usual brace with hinged bars at the side is an extra leather cuff inside of the outer cuff. This internal cuff is attached behind and, when laced, tends to prevent the brace from sliding up. This cuff can be laced much tighter than the outer one.

Three years' use of this brace on the

FIG. 1

Colorado College knee brace as for knee extended. Note strength of posterior bar.

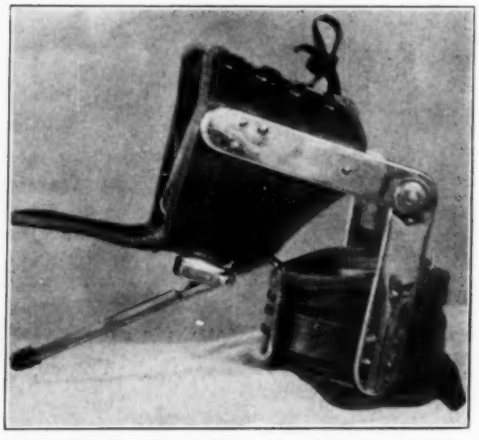


FIG. 2

Colorado College brace as for knee flexed.

football teams of Colorado College has demonstrated its effectiveness. At first glance it would appear that the posterior bar would be an impediment, but underneath either football trousers or ordinary street clothes it is not noticed and hugs the leg closely both in flexion and extension.

In addition to its usefulness on athletic teams we have found it most useful in convalescent knee cases where flexion and extension are desired, but where it is advisable to prevent any lateral motion of the knee.

FIG. 3

Brace applied to knee in extension, as in standing position.

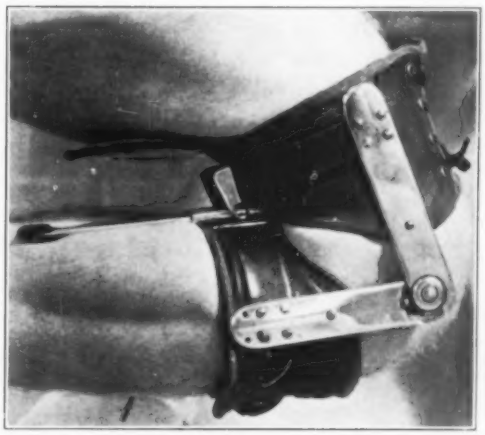


FIG. 4

Brace with knee flexed in position taken by a football player in the line.

During the past year Dr. G. W. Hawley has seen a number of these braces in use and has expressed the opinion that it is the only satisfactory knee brace he has seen. He has urged the writer to present it to the profession.

The author acknowledges his thanks to Mr. George Thornton of Colorado Springs for his cooperation in working out this ingenious hinged posterior bar.

SUBASTRAGALOID DISLOCATION WITH DISPLACEMENT OF ASTRAGALUS OUTWARD *

BY SAMUEL W. BOORSTEIN, M.D., F.A.C.S., NEW YORK, N. Y.

Unusual dislocations are of considerable interest, especially if they have been reduced successfully by the closed method. Hence, the writer is reporting this case, trusting that it may prove of interest to others, and perhaps may tempt them to try the same procedure.

S. B., male, aged thirty-nine years, an electrician, while cleaning a window on September 29, 1932, slipped off the chair and sustained an injury to the left ankle. He immediately noticed a deformity of the ankle, but felt only slight pain. He was taken at once by ambulance to Fordham Hospital where a roentgenogram was taken. He was seen by the writer two hours after the accident.

Examination revealed a deformity of the left ankle, almost like a club-foot, of the talipes equinovarus variety. The foot was bent inward and inverted at the astragalo-calcaneal joint. The internal malleolus was not palpable as it extended downward and outward; the external malleolus was displaced outward, almost piercing the skin. The entire foot was displaced downward and backward in an equinus position. The anterior aspect of the tibia was palpated freely at the anterior aspect of the ankle. The forepart of the foot at the calcaneoscaphoid joint was adducted as in a regular club-foot. The head and body of the astragalus were palpable at the outer aspect of the foot. There was no open wound.

FIG. 1

Before reduction.

* Read before the Bronx Surgical Society on November 28, 1932.

FIG. 2
After reduction.

Roentgenographic Examination: The anteroposterior view (Fig. 1) shows a complete, external, lateral dislocation of the astragalus, due to a subastragaloid dislocation. The os calcis is dislocated posteriorly and upward, so that it comes in contact with the internal malleolus at the lower end of the tibia. The astragalus lies on the external aspect of the os calcis. The mortise joint of the ankle has not been displaced. There is no evidence of a fracture.

Procedure: The patient was anaesthetized, with the knee flexed at a right angle to take the pull off of the tendo achillis. The plantar flexion was then increased to an angle of about 130 degrees. The heel was held firmly by an assistant, while the author abducted the forepart of the foot with the left hand and pushed the head of the astragalus inward with the right hand. The abduction of the forepart of the foot, with the dislocation of the head of the astragalus, was then easily corrected. It was found impossible, however, to bring the foot forward and execute dorsal flexion, which was necessary for the replacement of the body of the astragalus.

It occurred to the writer that the anterior parts of the tibia and fibula were not held firmly by that manoeuver, and thus the foot could not be pulled forward. Therefore, a loop of muslin was placed over the anterior part of the leg near the ankle and traction applied with the operator's foot held downward in the other part of the loop (in the manner advocated by Jones for the reduction of a Pott's fracture). The flexion of the knee was kept up. The foot was then manipulated as follows: plantar flexion was increased to an angle of 140 to 150 degrees. The foot was then pulled forward along the line of direction in which the tibia and fibula had been displaced. With his foot on the loop, the writer was able to pull the leg downward, while the foot was pulled forward, during which an audible snap was heard and the astragalus slipped into place. The forepart of the foot was abducted slightly to get the forepart of the foot in better direction, and the foot was then flexed dorsally to an angle of 90 degrees. A plaster cast from the toes to the middle of the thigh was applied, the foot kept at a right

angle and everted, and the knee flexed at a right angle to relieve the tension of the tendo achillis.

A roentgenogram, taken October 3, 1932, showed complete reduction of the dislocation (Fig. 2). The patient had no pain the day following the reduction.

On October 4, 1932, a window was cut in the cast at the outer aspect of the foot, over the head of the astragalus, to guard against pressure and slough of the skin where the head was pressing before reduction. The plaster above the knee was removed in ten days. The plaster was changed in two weeks and at the end of three weeks the patient was permitted to walk on the foot. The patient made a perfect recovery.

I wish to thank Dr. Guggenbuhl, the house surgeon, for his kind assistance in this case.

FREDERICK HENRY BAETJER

Dr. Frederick Henry Baetjer, Professor of Roentgenology at Johns Hopkins Hospital, died at his home in Baltimore on July 17. He was born on August 7, 1874. He received his degrees from Johns Hopkins University, he was an interne at this Hospital, and also followed for a year postgraduate courses in the University of Berlin. He devoted his entire life to the organization and development of the Department of Roentgenology at Johns Hopkins University, and was appointed Professor of Roentgenology in 1921. In his work Dr. Baetjer suffered injuries to his hands and eyes, but he labored on that the x-ray work might be put on a sound and scientific basis, and his contributions to that end were invaluable. Dr. Baetjer was a brilliant teacher; not only students but many doctors attended his daily clinics. He was a member of many medical and scientific societies, and was President of the American Roentgen Ray Society in 1911. He served as Major in the Medical Corps of the United States Army during the War. Dr. Baetjer was consultant roentgenologist to many of the leading hospitals in Baltimore and was the author of many valuable works on roentgenology, and his studies in regard to the value of x-ray findings in conjunction with the clinical findings in cases involving the bones and joints was an invaluable contribution to orthopaedic surgery.

News Notes

END RESULTS OF THE TREATMENT OF JOINT TUBERCULOSIS

REPORT OF COMMITTEE APPOINTED BY THE AMERICAN ORTHOPAEDIC ASSOCIATION *

Up to the present time this Committee is able to report on 235 cases from the clinics of Dr. F. C. Kidner, Dr. E. G. Brackett, and Dr. Emil Geist, and on 576 cases treated in the Lakeville State Sanatorium. These are cases from hospitals for adults and children, with the exception of Dr. Kidner's, in which all the patients are children. To obtain end results in these large hospitals for adults and children requires a long search, and it is extremely difficult, for patients discharged from these hospitals scatter to all parts of the world and do not follow instructions to report as to their condition. The only cases, therefore, in which we are sure of the end results are those of patients who we know have died. This is, therefore, a report of fatal cases.

Of 811 collected cases, the total number of deaths was 148, or eighteen and two-tenths per cent. Autopsies were obtained in twenty of the 148 cases. The presence of tuberculous micro-organisms was proved in eighty-six of the 148 cases.

At the Sanatorium at Lakeville, the percentage of deaths in reference to the region affected was as follows:

Spine	16.6 per cent.
Hip	17.0 per cent.
Knee	10.4 per cent.

Age: The age of the patient did not seem to have any relation to the death rate.

Region: The highest mortality occurred in disease of the low spine. In tuberculosis of the hip, males showed a larger mortality than females.

The occurrence of pulmonary disease: Fatal joint or osseous tuberculosis without active pulmonary disease is not uncommon. Of the fatal cases, thirty-seven per cent. showed active pulmonary disease; while sixty-three per cent. did not present pulmonary disease of any consequence.

Renal complications: Of the fatal cases, seven per cent. had tuberculous kidney disease.

NON-OPERATIVE TREATMENT

The non-operative treatment in these cases consisted of fixation, extension, and heliotherapy. Fixation was obtained by plaster apparatus and plaster-of-Paris jackets, leggings, and spicas; and the method was practically the same in all hospitals. Extension was obtained by weights and pulleys, or in spinal cases by plaster shells or Bradford frame with firm pad. These orthopaedic measures were used in practically all the hospitals.

OPERATIVE TREATMENT

Operation was attempted in only thirty of the 148 cases.

Duration: Of the twenty knee cases, fourteen died in less than one year; of forty-one hip cases, fifteen died in less than one year; of eighty-eight spine cases, forty-five died in less than one year. It should be stated that some of these patients did not enter the hospital until they were *in extremis*.

* Presented at the Annual Meeting of the American Orthopaedic Association at Washington, D. C., May 9, 1933, by Z. B. Adams, M.D., Chairman.

Frequency of meningitis and amyloid disease: Of twenty knee cases, five per cent. died of meningitis and ten per cent. of amyloid disease; of forty-one hip cases, about twenty-seven per cent. died of meningitis and about twenty-seven per cent. of amyloid disease; of eighty-eight spine cases, fourteen per cent. died of meningitis and nineteen per cent. of amyloid disease.

EMIL GEIST, M.D., Minneapolis, Minnesota
F. C. KIDNER, M.D., Detroit, Michigan
R. I. HARRIS, M.B., Toronto, Canada
J. O. WALLACE, M.D., Pittsburgh, Pennsylvania
Z. B. ADAMS, M.D., *Chairman*, Boston, Massachusetts

The Annual Roll Call of the American Red Cross to enroll members for 1934 will be held from Armistice Day to Thanksgiving Day, November 11–30, 1933.

The pupils and friends of Professor Nové-Josserand, of Lyon, have formed a plan to present to him a medal of honor in commemoration of his thirty-five years of active hospital service. The medal is designed by Albert Herbemont and represents the Professor and a view of the old *Hôpital de la Charité* which has been the seat of his professional activities. Any donation to this fund by the friends and admirers of Professor Nové-Josserand will be received by Dr. André Rendu, 33 rue Sala, Lyon. The subscription of 100 francs will entitle the donor to a copy of the medal.

The International Society of Orthopaedic Surgery met July 19 to 22, 1933, at the Royal Society of Medicine in London, under the presidency of Prof. G. Nové-Josserand, of Lyon. The meeting was well attended, there being over 100 members present. The Committee appointed from the English members spared no pains to make the meeting a success and the plans were well arranged and carried out.

The symposium on the first day considered the mechanism of joint movements in general. Papers were read by Dr. H. von Bayer, Heidelberg; Dr. Francesco Delitala, Venice; and Dr. Richard Scherb, Zurich. The second scientific session considered the treatment of tuberculous arthritis of the hip joint. Papers were read by Dr. Philipp Erlacher, Graz; Dr. A. Maffei, Brussels; Dr. Étienne Sorrel, Strasbourg; and Dr. Melvin S. Henderson, Rochester, Minnesota. In the afternoons clinics were held at the London hospitals and these were well arranged and well attended. In the evening social events were held and the banquet, a brilliant affair, was held in the Dorchester Hotel, over 140 being present. The last scientific session on July 22 was devoted to a number of contributions by different members, more particularly on the technical questions and treatment. The afternoon was spent visiting the Lord Mayor Treloar Cripples' Hospital and College at Alton.

Dr. Murk Jansen of Leiden was made President-at-Large, Prof. V. Putti of Bologna, President, and Dr. Fred Albee of New York, Vice-President. The next meeting is to be held in Rome in 1936.

Current Literature

FRACTURES. By Paul B. Magnuson, M.D. Philadelphia, J. B. Lippincott Company, 1933. $5.00.

The author is writing mainly from his own practical, surgical experience—a valuable feature in any work on fractures—for the author passes on to his readers the methods by which he has met the problems which come to any surgeon who deals largely with this group of cases. He states that the object of the book is to give aid to the surgeon who first sees the fracture and to enable him to apply the necessary treatment at that most important time and, therefore, to avoid many of the unfortunate sequelae so often met with as well as much of the prolonged after-treatment.

The first four chapters are devoted to the discussion of general information on this subject and include the pathology and repair as well as the equipment necessary in the treatment,—including the forms and methods of application of splints and plaster.

In general, the operative procedures, except those necessary for the first treatment in some cases, are not given a prominent place—and with good judgment—for the main object of this book is to give information relative to the first treatment of fractures rather than to attempt a consideration of the entire subject.

The special fractures are then taken up regionally. A description of the types of fractures which occur in the different anatomical regions and of the anatomical conditions which influence the displacement of the fragments is followed by the technique of reduction and retention. The simplest methods of treatment sometimes advisable in the early periods are considered.

A chapter is devoted to the features of the postoperative treatment of various fractures, including instruction in regard to the proper therapy in treating fractures of the lower extremity which involve the joints. The author emphasizes the necessity of care of treatment in therapy and the need of direction on the part of the surgeon,—a supervision the value of which cannot be too strongly urged. In the portion treating of dislocation and fractures, the neurological features are considered at length, which is particularly helpful in the diagnosis and prognosis; and, since this book deals mainly with the first treatment of fractures, the value of attention to this part of the subject is having increased appreciation. The book is a particularly practical one.

LE DISQUE INTERVERTÉBRAL. PHYSIOLOGIE, PATHOLOGIE ET INDICATIONS THÉRAPEUTIQUES. By G. Mauric. Paris, Masson et Cie, 1933. 35 francs.

The work of Professor Schmorl has stimulated some of the best scientific minds to the further study of the intervertebral disc and the pathological changes which are associated with the injury of the various parts of its structure. These continued studies of this important subject are particularly valuable, for they link up the increasing knowledge of the pathological changes with the clinical data which the persistent investigations are disclosing, as well as the differentiation of those other conditions which show so great a similarity in both the roentgenographic and the clinical findings.

The author of the book has brought into his work both a clinical experience and a careful anatomical study, and has presented the results obtained by these two methods of investigation and has linked together the pathological and the clinical data. There is a careful presentation of the anatomy of the disc, and a review of the published work, but this historical review is more than a review, for it is the result of his own investigations, supplemented by the work already done by many authors. The pathology of the disc and the affections of the vertebral column, including the various forms of spondylitis and also the arthropathies, which are associated with change in this disc, are considered in relation to its structure and to the injuries or changes in development of the nucleus pulposus. The anatomy of the disc in different periods of life from the newly born to the

senile stage is given, and the conclusions from this study are presented as a brief summary,—a most convenient form to obtain a review of this portion of the subject. The author carries his discussion beyond the immediate affections of the disc and fractures and changes of the nucleus pulposus and the conditions resulting from this disturbance, and deals with the general affections of the spinal column, including the different forms of spondylitis and arthropathy and also the involvement of the nerves and the cord due to secondary changes. It is valuable to have a clear statement of the connection between the effects of the disturbances of the nucleus pulposus and the involvement of the spine and the distinction between them.

Little has heretofore been studied in regard to the subject of the nerve and cord pressure by the injury and the malformations of the disc which originate in the nucleus pulposus, but, from a study of a large number of case observations, the author has been able to discuss this portion of the subject from a practical point of view and its importance is clearly demonstrated.

ROSE AND CARELESS' MANUAL OF SURGERY. Edited by Cecil P. G. Wakeley, D.Sc., F.R.C.S., John B. Hunter, M.C., M.Chir., F.R.C.S., and William T. Coughlin, B.S., M.D., F.A.C.S. Ed. 14. Baltimore, William Wood and Co., 1933. $9.00.

This new edition has been especially revised and rearranged to meet American needs.

Intended for students, it is to be praised for insistence on basic principles, for careful system and classification and for the presentation of a vast amount of information in a broad educational view of the subject. Also, the conservatism in point of view, the refusal to follow false enthusiasms, is fine. Nothing could be better than the paragraph on page 496, outlining what is *really* of value in the surgery of infantile paralysis cases.

One finds the same terse, common-sense point of view through the excellent chapters on abdominal and urological surgery.

Unfortunately the chapters touching on bone and joint work cannot be praised as freely, though the chapters on deformities and on joint disease suffer mainly from lack of space. Diseases of bone fare less well. Page 630 gives nothing like a plan of treatment or a perspective in myeloma (our giant-cell tumor) and, after all, Ewing's tumors are radiosensitive—for palliation at least.

Fractures need far more than the hundred pages here allowed and one condones omission, but there is, throughout this section, a vagueness as to what one does meet, what one does to it, and what is probably going to happen.

Fractures of the carpus give late trouble more than "occasionally" and the operative problem is worth more than a word. The account of compression fracture of the spine betrays no familiarity with this much discussed subject, and in relation to os-calcis fractures we are given vague advice which seems to apply to the rare avulsion type only, nothing as to treatment or outlook in the rather common and very serious compression fractures on which much good work has been done.

But, it is a good text book, full of substance—defective only, perhaps, as any book must be that attempts the impossibility of covering so broad a field.

THE PHYSIOLOGICAL EFFECTS OF RADIANT ENERGY. By Henry Laurens, Ph.D. (American Chemical Society Monograph Series.) New York, The Chemical Catalog Co., Inc., 1933. $6.00.

Exaggeration of the "vital importance of sunlight" has prevailed during the past twelve years. Professor Laurens says: "Claims for its virtue have since been discredited, therefore placing patient and physician in a more true relationship with the merits of this form of treatment, . . . radiation is only one of the environmental factors that may affect vitality.

". . . Nevertheless, radiant energy does play an interesting part in animal physiology, and is in some cases a remedial agent."

Four paragraphs deal with the use of radiant energy in the treatment of osteo-articular tuberculosis. The value of the text should not be based on this fact. The clinician learns from this high authority that, "the effect of radiation alone on bone tuberculosis is still a matter of conjecture. . . . Until more is known about selective radiation in the cure of tuberculosis of bone from the experimental standpoint, its specific action must continue to be a matter of speculation. While heliotherapy undoubtedly plays a large part in the results reported at Leysin (Rollier), it is only a part, not the whole, of the régime." Such conclusions are sound and favor careful consideration of other statements made by the author, although the reader may not fully agree.

For those interested in heliotherapy, or the therapeutic use of radiation from artificial sources as a substitute, a valuable service has been rendered by both the author and the American Chemical Society, in the publication of these fourteen chapters with nearly 800 references, covering a fifteen-year period.

DAS WESEN DER SCHWEDISCHEN MASSAGE UND IHRE ANWENDUNG BESONDERS AUF DEM GEBIETE DER ORTHOPÄDIE. Beilageheft zur *Zeitschrift für Orthopädische Chirurgie*, Bd. 59. By Dr. Konrad Port, Stuttgart, Ferdinand Enke, 1933. 60 marks.

In this work of 171 pages, the author emphasizes the usefulness of this form of treatment in numerous conditions of bones, joints, and muscles. Many of the long-standing, painful ailments, commonly found in joints and especially in muscles, can be cured or definitely improved. Emphasis is laid on the necessity of thorough training in the work, even for the physician, in order to obtain the skill needed in detecting pathological conditions as well as removing them.

The author calls attention to the distinction between the method of superficial massage which is ordinarily employed and the method used by the Swedish school.

The disease conditions for which this remedy can be successfully applied are grouped under the headings of chronic rheumatism, myalgias, static deformities, and traumata. Excellent descriptions are given of the subjective symptoms and the objective findings. Illustrations and x-ray reports are omitted, although numerous case reports are included in the discussions.

It is safe to say that a more general application of the principles advocated by the author would be a distinct help in relieving many cases of prolonged disability. It is, therefore, reasonable to expect that, in the first place, industrial surgeons would avail themselves of a method of treatment which has stood the test of a long period of time.

THE CONTROL OF FOOTBALL INJURIES. By Marvin A. Stevens, M.D., and Winthrop M. Phelps, M.D. New York, A. S. Barnes and Co., Inc., 1933. $3.00.

The book undoubtedly fills a long felt want, in giving something concrete for the coach or trainer and doctor connected with football teams to turn to for reference.

The book—supposedly being written for coaches, trainers and medical advisers—discusses many and sundry types of injuries sustained in athletics, but fails to discuss the differential diagnoses and is lacking in details of specific treatment. It does not emphasize the possibility of seemingly trivial injuries becoming serious, which surely is one of the most striking observations to be made by medical men connected with athletic squads.

The portions of the book devoted to diagnosis and treatment are not sufficiently detailed for a medical reference book, yet contain enough information which when placed in the hands of non-medically trained coaches or trainers—who unfortunately are in charge of the care of injuries in the majority of schools or colleges in America—may make them more dangerous than ever.

There is much valuable information for the coach regarding methods of instruction—the handling of the body and ways by which the player can protect himself from injury. Stressing adequate medical examinations of prospective football candidates, and insisting on medical supervision of athletic squads are points extremely well taken.

The book is profusely illustrated—for the most part cuts from movies of actual games.

While these are interesting from a football man's point of view, they are too small to be of value in illustrating mechanisms by which injuries are produced.

Since the authors have particularly in mind the coach and the trainer, the emphasis is naturally laid on the information intended for them.

MASSAGE AND REMEDIAL EXERCISES IN MEDICAL AND SURGICAL CONDITIONS. By Nöel M. Tidy (Princess Mary's Royal Air Force Hospital, Halton, England). Baltimore, William Wood and Co., 1933. $5.25.

This handbook, prepared, as the author states, for "senior and junior students of physiotherapy", fulfills its purpose. It is a well balanced résumé of many surgical and medical conditions in which massage and therapeutic gymnastics should play a rôle too often insufficiently assigned to them.

For the most part, the plan for each subject includes definition, classification, symptoms, pathology, and treatment. The physician and surgeon will find a repetition of much that he knows in the preliminary treatment of each subject; the physiotherapeutist will be able to get the setting of each subject clearly and succinctly. It is in the paragraphs on treatment that the book is most valuable to the physiotherapeutist, as well as to the physician or surgeon who wishes to know more about massage and corrective gymnastics. To each subject is given a brief outline of recognized treatment, a statement of the place of massage and remedial exercises in the entire treatment, and usually a statement of the types of massage to be used and a list of beneficial exercises. At times the nomenclature of these exercises differs from that in general use in America, but the simplicity of the descriptive words used is such that one familiar with corrective exercises may readily understand them. The illustrations, of which there are perhaps not enough, aid in interpretation of the exercises. The exercises outlined are largely in conformity with those most used in America.

It is refreshing to read a book, written by a specialist in physiotherapy, which does not lay undue emphasis upon the one phase of treatment which she knows. One gets the impression that the author does know her subject well, but that she also has been much in touch with physicians and surgeons in her work and realizes that there must be more than "one string to her bow", when treating disease and deformity. This book is a valuable addition to therapeutics.

THE AMERICAN ILLUSTRATED MEDICAL DICTIONARY. By W. A. Newman Dorland, A.M., M.D., F.A.C.S. Ed. 16. Philadelphia, W. B. Saunders Co., 1932. $7.00; with Thumb Index $7.50.

The medical public will welcome the sixteenth revised edition of the American Illustrated Dictionary which has recently appeared. This work has won its place in the medical world and the new, rapidly changing and increasing terms which are an accompaniment of the advances in medicine and surgery make such a work still more necessary. To meet this need 3000 new words and terms have been added, many times with ample description of new methods or processes which they designate. The definitions are also frequently illustrated and many drawings and photographs have been added to those already in the previous editions.

This work is a complete dictionary of terms used in medicine, surgery, dentistry, pharmacy, biological chemistry, nursing, veterinary science, biology, and medical bibliography. It is a book of 1493 pages and 941 illustrations. But it is more than a dictionary, for it gives brief and valuable information on very many of the subjects which the words represent.

There are also special tables of staining methods and tests, etc., which give the necessary directions for their use, and many of the topics and subjects are very thoroughly illustrated, many times with colored photographs. This portion of itself makes the work a handy book of reference to the practical medical man.

An interesting feature also is the portraiture and brief mention of prominent men who

have contributed to the science of medicine and who have given their names in the development of the terminology of medicine. As a descriptive feature are line drawings and photographs portraying anatomical and pathological structures of the body,—for instance, the formation of joints with the distribution of the ligaments, etc., also special systems of circulation.

The work could be called a dictionary and a reference book, and this new edition will find its place with all active medical men and in libraries.

THE JOY OF LIVING. AN AUTOBIOGRAPHY BY DR. FRANKLIN H. MARTIN. Garden City, Long Island, Doubleday, Doran and Co., 1933. 2 Vol. $7.00.

The title of this book is a happy introduction to a detailed account of the experiences of one who encountered and passed successfully through the physical hardships of early life. It suggests, and perhaps illustrates, the important part which those early struggles, combined with a native capacity, often play in determining that success which comes later in the real periods of a man's career.

It is as an organizer and as an administrator that Dr. Martin is best known, and will always be regarded. He has the vision to see things in their larger relations and their possibilities of development in perspective, and such vision has served him in the establishment of the several successful projects in which his initiative has been so evident. He has had the judgment to recognize the time when some of these larger movements in the medical world were ready to be put into action.

The second volume is confined to the consideration and discussion of some of the medical activities during the war. From his position as a member of the Advisory Commission to the Council of National Defense, and as Chairman of the General Medical Board, he was intimately conversant with many of the more important movements which mobilized so large a number of medical men into an active service.

This Advisory Commission was in close contact with other mobilized bodies of citizens and could give the benefit of its counsel and play an important part in unifying the various efforts in that critical and difficult time. In these positions, Dr. Martin employed his unusual powers of organization toward accomplishing such unification of these agencies. The medical profession will take particular interest in this historical review of this tense and critical period in which it supplied a sudden need and played an active part. The book is full of interesting episodes, many of them personal, covering the time from boyhood, through early professional and later administrative periods of the author's life.

A SYNOPSIS OF SURGERY. By Ernest W. Hey Groves, M.S., M.D., B.Sc. F.R.C.S. Ed. 10. New York, William Wood and Co., 1933. $5.00.

American surgical literature is singularly lacking in texts of this character. The plethora of reference books on surgery, patterned mostly after one standard model, has resulted in the crowding of book shelves with many volumes, the size and number of which have a tendency to increase steadily, to which reference is only rarely made by the busy practitioner, and which are too detailed and exhaustive for the average student. English surgeons and teachers have shown an appreciation of the desirability of a small, well indexed, and succinct epitome of accepted surgical practice and the publishers of this little volume of Mr. Groves's have rendered a great service to American surgeons and students in bringing out this revised tenth edition. It will be found to be an extremely comprehensive and sound guide to modern surgical diagnosis and practice and, though it may not supplant entirely the need for a more exhaustive treatise, will certainly be referred to far more frequently than the more pretentious treatises on surgery.

HISTORY AND SOURCE BOOK OF ORTHOPAEDIC SURGERY. By Edgar M. Bick, M.A., M.D. New York, The Hospital for Joint Diseases, 1933. $1.50.

The author states that the object of this book is to give a history of Orthopaedic Surgery from ancient times to the present day, and he has presented a review of the

growth of Orthopaedic Surgery, beginning with the practices of those earliest times, as shown by the remains of primitive man. It is interesting to find how much can be learned of the methods by the fragmentary evidence of those periods. He has first traced the development through the various epochs by means of the different methods and appliances in use in those times, and, through their application, has shown the influence of the principles employed. The pathological and traumatic affections of bones and joints evidently excited a great deal of interest in those earlier periods, and many of the mechanical principles then in vogue are now applied in a modified way. One can also form an opinion through this information of the type of men who have occupied themselves with this special work. In the more modern times he traces the development through the evolution of surgical procedures resulting from the increased knowledge of the fundamentals of medicine and surgery, and he leads to the present status of this specialty and its influence on the development of institutions which are essential parts of the methods and procedures of the present day. This book will be found to be full of historical interest. The very large amount of material is well arranged and the story is told in a way to interest the reader.

The Journal wishes to acknowledge the receipt of the following publications sent to the Editorial Department:

Bulletin of the National Tuberculosis Association, XIX, Nos. 8, 9, 1933.

Bullettino e Atti della Reale Accademia Medica di Roma, LIX, Fasc. 1–5, 1933.

Cirugía Ortopédica y Traumatología, I, Num. 1–3. Havana, 1933.

Fondation de la Clinique-Manufacture Internationale du Dr. A. Rollier, à Leysin. Rapport de 1932.

The Journal of the Indian Medical Association, II, Nos. 5–10. Calcutta, 1933.

Journal de Médecine de Bordeaux et du Sud-Ouest, CX, No. 16, 1933.

Knochenbrüche und Unfallchirurgie in ihren Beziehungen zur Umwelt. Lorenz Böhler. Vienna, Wilhelm Maudrich, 1933.

Entstehung, Erkennung und Behandlung der Fersenbeinbrüche. Lorenz Böhler. Vienna, Wilhelm Maudrich, 1933.

Medico-Surgical Suggestions, II, Nos. 5–7. Madras, 1933.

Hospital for Joint Diseases of the City of New York, Twenty-Sixth Annual Report, 1932.

Norsk Magasin for Laegevidenskapen, XCIV, Nr. 7, 9. Oslo, Norway, 1933.

Slovanský Sborník Ortopedický, VIII, Sešit 3, 4. Brno, Czechoslovakia, 1933.

Boletines y Trabajos de la Sociedad de Cirugía de Buenos Aires, XVII, Nos. 1–19, 1933.

La Tribuna Médica, VII, Nos. 196–203. Havana, 1933.

Verzeichnis der Ärztekurse im Studienjahre 1933–1934. Das Kursbüro der Wiener Medizinischen Fakultät. Vienna, 1933.

Experimentelle und Klinische Studien über Avertinnarkose. Nils Gyllensvärd. (Acta Chirurgica Scandinavica, LXX, Supplementum XXII.) Helsingfors, Finland, Mercators Tryckeri Aktiebolag, 1933.

Studien über die Gaswechselverhältnisse im Darm bei Sogenanntem Paralytischem Ileus. Eine Klinisch-Experimentelle Untersuchung. Herman Wahren. (Acta Chirurgica Scandinavica, LXX, Supplementum XXIII.) Stockholm, Kungl. Boktryckeriet, P. A. Norstedt & Söner, 1933.

Zur Behandlung der Appendicitis-Peritonitis. Mit Besonderer Berücksichtigung der Frage nach Primärsutur und der Behandlung von Postoperativem Ileus. Eine Klinische Studie. Gunnar Bauer. (Acta Chirurgica Scandinavica, LXX, Supplementum XXIV.) Lund, Sweden, Berlingska Boktryckeriet, 1933.

Beiträge zur Kenntnis der Postoperativen Blutveränderungen. Peter Windfeld. (Acta Chirurgica Scandinavica, LXX, Supplementum XXV.) Copenhagen, Levin & Munksgaard, 1933.

HALLUX RIGIDUS UND SEINE BEHANDLUNG (Hallux Rigidus and Its Treatment). J. P. Strömbeck. *Acta Chir. Scandinavica*, LXXIII, 53, 1933.

A review of the literature and the detailed reports of twenty-three personal cases cover the subject of hallux rigidus in monographic style. Contracture of the short flexor of the great toe and the soft parts of the plantar surface is the usual cause of limited dorsiflexion. Arthritis of the basal joint is a common etiological factor. Excessive weight-bearing on the congenitally long narrow foot with a long first toe and metatarsal predisposes to deformity of the first metatarsal head. X-ray tracings of the first metatarsals in the writer's cases are shown in aggregate.

Operative treatment is usually successful, but arthrodesis of the basal joint is to be avoided. Occasionally removal of the dorsal exostosis is sufficient. In the mild case the short flexor may be tenotomized, but in the severe one the proximal end of the proximal phalanx must be resected.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

A CLINICAL STUDY OF THE CAUSATION OF PSEUDARTHROSIS OF THE DIAPHYSES OF THE LONG BONES OF THE EXTREMITIES. Arvid Hellstadius. *Acta Chir. Scandinavica*, LXXIII, 111, 1933.

On the basis of a study of eighty-one non-unions of the shafts of long bones, the writer arrives at numerous conclusions, some of which are as follows:

In cases of pseudarthrosis in which multiple fractures had been present, the union of several fractures is simultaneously inhibited.

A relative deficiency of vitamin C has not been proved an influence in producing pseudarthrosis.

The tendency to non-union is slight in childhood.

The arterial blood supply to the diaphysis may possibly play some part in the production of pseudarthrosis.

Seven per cent. of compound fractures resulted in non-union. Simple fractures treated by operation yielded 2.4 per cent. and those by closed methods 0.23 per cent. pseudarthroses. Operations performed in the first three days gave a higher percentage of non-unions than those done at a later stage.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

ZUR BEHANDLUNG VON LORDOKYPHOSENZUSTÄNDEN BEI KINDERN UND JUGENDLICHEN (The Treatment of Lordosis-Kyphosis Deformities in Children and Adolescents). Mauritz Persson. *Acta Orthop. Scandinavica*, IV, 182, 1933.

The principle of the Haglund scoliosis jacket has been successfully utilized in the correction of several cases of kypholordosis. With the patient bending forward so that the back is horizontal and "buckled like a cat's", a plaster cast is applied to the torso. A window is cut over the lumbosacral region instead of over the abdomen. As the patient straightens up, there is passive correction of the double curve, which is in part active of the kyphosis.—*W. P. Blount, M.D., Milwaukee, Wisconsin.*

IRRADIATION IN THE TREATMENT OF BONE TUMORS. George E. Pfahler. *Am. J. Cancer*, XVIII, 318, 1933.

The author presents a general paper on radiation therapy in bone tumors, and a review of his previously published results in the treatment of osteogenic sarcoma. He reports 25 per cent. (nine out of thirty-six) of his series as well and symptom-free at the end of five years or more. All but one of these cases had the benefit of operation as well. He concludes that "preliminary irradiation of the tumor area and irradiation of the pulmonary area followed by amputation has given us the best results to date".

The author states that in giant-cell tumors radiation is the treatment of choice. In no case has he failed to obtain definite improvement. With young patients there is definite evidence of repair within a month after treatment is started. He has never seen damage to normal bone growth caused by radiation of these tumors. There is no need

of carrying the treatment to the extent of causing skin changes. In his experience recalcification is delayed if there has been an operation on the tumor before radiation therapy is begun.

Radiation is of great palliative benefit in cases of Ewing's tumor, Hodgkin's disease of bone, and multiple myeloma. Among metastatic bone tumors, cancer of the breast and thyroid yield better than others to radiation therapy. Pathological fractures due to metastatic cancer frequently unite under radiation.

The paper is well illustrated with roentgenograms and case histories, and gives some details of the technique of the therapy employed.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

MALIGNANT GROWTHS FOLLOWING RADIATION. Editorial. *Am. J. Cancer*, XVIII, 622, July 1933.

After review of the well known examples of the development of malignancy in areas subjected to radiation, either experimentally or clinically, the editor concludes that irradiation alone, unless serious tissue lesions are produced, is not sufficient for the induction of malignant changes. The presence of inflammatory changes in the tissues renders them more susceptible to malignant degeneration under the influence of radiation. It is stated that there are now recorded eighteen examples of sarcoma following irradiation of joint tuberculosis in human beings. Obviously the raying of tuberculous joint lesions should be avoided if healing can be produced by any other type of therapy.—*Grantley W. Taylor, M.D., Boston, Massachusetts.*

TUMORS OF THE PARATHYROID GLAND. Report of Two Cases. F. W. Rankin and J. T. Priestley. *Am. J. Surg.*, XX, 298, 1933.

The authors report two cases of tumor of the parathyroid gland with generalized osteitis fibrosa cystica. Removal of the tumor in one case resulted in cure of the symptoms of weakness and pain in bones and joints.

In the other case death followed seventy-eight days after operation. The patient, a woman aged forty-seven years, developed anorexia, vomiting, tetany unrelieved by intravenous parathormone and calcium, nutritional oedema and, finally, extreme weakness and prostration with death. At autopsy there were found three small, normal parathyroid glands which were apparently insufficient to carry on the necessary function. In this case there was extreme instability of the blood calcium and phosphorus following operation.

It is suggested that information at hand now does not justify parathyroid surgery except in the case of generalized osteitis fibrosa cystica, and even in such a case one must take care to leave undisturbed enough parathyroid tissue to carry on the function normally.

A short discussion of a few of the points in operative technique is given.—*Allan Lloyd, M.D., Iowa City, Iowa.*

MADURA FOOT. A Third Case of Monosporosis in a Native American. Moses Gellman and J. A. Gammel. *Arch. Surg.*, XXVI, 295, 1933.

This condition was termed so by the natives of India to designate a deformity of the foot most commonly seen in the vicinity of Madura. It is a mycetoma, a growth or granuloma characterized by sinus formation. White, yellow, black, or red granules made up of fungous elements are found in the discharge or embedded in the pathological tissue, which differentiates it from other mycoses. The maduromyces have grains composed of large segmented mycelian filaments possessing well defined walls and usually chlamydospores (actinomycoses are non-segmented).

A third case of monosporosis occurring in a native adult negro American is reported. These mycetomata rarely respond to medical treatment but require surgical amputation, as did this case. A mycosis should always be considered in all cases of chronic osteo-

myelitis, tuberculosis, or syphilis. This fungus injected into the knee joints of rabbits resulted in a purulent arthritis with periarthritic abscesses from which cultures were positive, this being the first instance in which experiments of this nature on animals, carried out in the United States, yielded positive results.

Clinically, this patient demonstrated a marked destruction of all the bones of the foot. Biopsy indicated syphilis or tuberculosis. The leg came to amputation. Pathological examination demonstrated the granules.—*J. Kulowski, M.D., Iowa City, Iowa.*

RESECTED KNEE JOINTS. R. K. Ghormley and E. A. Brav. *Arch. Surg.*, XXVI, 465, 1933.

A study has been made of the clinical history, roentgenograms, lesions discovered grossly and microscopically, and results of inoculation of guinea-pigs in a series of 236 resections and nine amputations of the knee joint. One hundred and twenty of these joints were totally intact for complete study. An analysis is given in detail, covering the main features,—such as gross and microscopic pathology, etc.

Of particular interest is the following summary:

The preoperative diagnosis was incorrect in 24.4 per cent. of the cases of tuberculosis and in 13.7 per cent. of the non-tuberculous arthritic cases. The gross specimens and x-rays varied so considerably that it was often impossible to arrive at an accurate diagnosis. The inoculation of guinea-pigs proved incorrect in 12.5 per cent. of the twenty-four cases in which this was done. The diagnosis made by biopsy and other operative tissue was accurate in all but 3.2 per cent. of the cases, an error of omission.

In 168 of these cases tuberculosis was found by microscopic examination or guinea-pig inoculation. Sixty-six cases were end results of septic joints, old traumatic joints, and old osteomyelitis. Nine were cases of atrophy and two of Charcot's disease.

In comparing the specimens and history it was found that, as a general rule, the progress of the non-tuberculous types of infection was much more rapid than of the tuberculous. In 56 per cent. it appeared grossly that the condition was advanced in all the tissues, in 37.2 per cent. it appeared to be primarily in the synovial membrane, and only 6.8 per cent. evidenced primary osseous lesions. By the time a diagnosis is clinically possible, the lesion is wide-spread and the initial localization is of little practical significance. In 34.4 per cent. the site of the lesion was in the tibia, in 10 per cent. in the femur, and in 3 per cent. in the patella; the rest could not be determined (52.6 per cent.).

In the tuberculous cases the destruction of cartilage was due to the pannus formation, subchondral granulation, and attrition; whereas in the non-tuberculous, the cartilage was denuded by attrition and digestion. In 29.4 per cent. of the tuberculous forms, the cartilaginous destruction was greatest at the margins of the joint, while in 20.6 per cent. it was definitely greater at areas of pressure. In twenty-nine cases sequestra of varying sizes were noted in the tuberculous group.

In all cases in which changes are apparent in the roentgenograms, the disease is probably well advanced, particularly in tuberculosis. In 45.5 per cent. of the non-tuberculous group there was more cartilaginous destruction than was evident in the x-rays. On the other hand, actual osseous changes were exaggerated on the x-ray film, but in only seven cases were sequestra demonstrated. All in all, the x-ray may be inconclusive and even misleading.

The actual histological examination of sufficient tissues leads to the least error in diagnosis. A negative tuberculin reaction is of more significance as being against a diagnosis of tuberculosis.—*J. Kulowski, M.D., Iowa City, Iowa.*

BEITRAG ZUR BEHANDLUNG DER SCHENKELHALSFRAKTUR: FEMORO-PELVINE VERSCHRAUBUNG NACH HOTZ (Contribution to Question of Treatment of Fracture of Femoral Neck: Femoro-Pelvic Screw Fixation of Hotz). H. Hillebrand. *Beitr. z. Klin. Chir.*, CLVII, 266, 1933.

The Whitman abduction method of treatment of fracture of the neck of the femur is,

in general, the procedure of choice. However, in certain cases where conditions are unfavorable for this form of treatment, osteosynthesis according to the method of Hotz produces very satisfactory results. This consists of securing the fragments by means of a metal screw through the trochanter, neck, head of the femur, and the acetabulum. A modification of this method is now used by the author, in which the acetabulum is not included.

This procedure has been used in nine cases. In seven, good functional results have been obtained, and in the other two the results were satisfactory. The period of convalescence has been very materially shortened.

Reports of nine cases are briefly given in the article. There is also a complete description of the technique of the operation, as well as the indications for this operation.—*R. J. Dittrich, M.D., Fort Scott, Kansas.*

Acute Infective Osteomyelitis. A Review of 262 Cases. L. N. Pyrah and A. B. Pain. *British J. Surg.*, XX, 590, 1933.

This is a study of a ten-year period of the cases in the General Infirmary at Leeds. Seventy-one of the 262 cases were fatal (27 per cent.). Of fifty-one cases submitted to autopsy, all but six showed pyaemic lesions. The causative organism was most commonly staphylococcus aureus.

All cases were operated on. In forty-six instances, incision and drainage of the subperiosteal abscess was all that was done at the primary operation and there were eleven deaths. Sixteen others had the same operation but required secondary operations.

The gutter operation was done primarily 176 times with fifty-two deaths. Primary partial diaphysectomy was the operation in twenty instances with but one death. Two cases were treated by the Orr method and both patients died.

The writer concludes that a moderately conservative treatment is the best policy.—*Ernest M. Daland, M.D., Boston, Massachusetts.*

Serum Therapy in Poliomyelitis. Jean Macnamara. *British Med. J.*, I, 526, Mar. 1933.

Stimulated by Simon Flexner's recent article, Dr. Macnamara reviews the records of clinical experience with immune human serum in the treatment of poliomyelitis. She rightly points out the many difficulties in applying this form of serological treatment, (variations in potency of available serum, lack of standardization of the product, difficulties in reaching any uniform, standardized unit, difficulties in obtaining human serum, and its cost). After reviewing all the published evidence, she concludes that the facts do not by any means indicate that the serum is of no value. She concludes on a note of hope that further and more carefully controlled use of the serum will prove it to be of value.—*R. I. Harris, M.B., Toronto, Canada.*

Muscle Extract Treatment of Intermittent Claudication. Maurice Newman. *British Med. J.*, I, 611, Apr. 1933.

Newman discusses the evidence supporting the idea that various types of tissue extract and particularly muscle extract have vasodilating powers. He has applied this principle to the treatment of eleven cases of intermittent claudication. Of these, nine cases received great benefit and relief of symptoms. The treatment he describes appears to be similar in principle to that with acetocholine,—*viz.*, the administration of a drug having definite power of vasodilatation of peripheral arterioles.—*R. I. Harris, M.B., Toronto, Canada.*

Transitory Arthritis of the Hip-Joint in Childhood. An Investigation of Arthritis of the Hip in Ninety-Seven Children. R. W. Butler. *British Med. J.*, I, 951, 1933.

Butler relates the histories of a group of children sent to the tuberculosis hospital at

Pyrford with low-grade arthritis of the hip in whom it was not possible to make a definite diagnosis of tuberculosis of the hip on admission. These were called "observation hips". Careful follow-up revealed that three proved later to be tuberculous. Of the twenty-two non-tuberculous cases, two were hysterical hips and one was probably a syphilitic lesion, since it cleared up together with other definite syphilitic lesions under appropriate treatment. The remaining nineteen cleared up spontaneously after varying periods of time. Fever was present in six. Trauma did not play any part. After discussing the possible etiological factors, Butler concludes that low-grade infection is the most probable cause.—*R. I. Harris, M.B., Toronto, Canada.*

A Case of Osteitis Deformans Treated with Parathormone. G. H. Colt and A. Lyall. *British Med. J.*, II, 10, July 1, 1933.

Colt and Lyall report a case of osteitis deformans treated with parathormone with apparent improvement. The chief involvement was in the cranium and femur where a pathological fracture occurred. Parathormone appeared to cause rapid healing of the fracture and relief from the symptoms due to pressure on cranial nerves.—*R. I. Harris, M.B., Toronto, Canada.*

Fractures of Both Bones of the Leg. E. N. Wardle. *British Med. J.*, II, 146, July 22, 1933.

Wardle reviews the results obtained in forty-eight cases of fracture of the tibia and fibula treated by himself. His paper is a plea for manipulative reduction of these fractures rather than open reduction or skeletal traction. He believes that absolute anatomical restoration of the fragments is not necessary for good functional results. He strives to restore length and alignment and maintain good movement in the ankle and knee. His objections to open operation are that it delays union, and to skeletal traction that it invites infection and traumatizes joints.—*R. I. Harris, M.B., Toronto, Canada.*

Spinal Curvatures—Visceral Disturbances in Relation Thereto. N. T. Ussher. *California and Western Med.*, XXXVIII, 423, 1933.

The author reviews the literature on the relationship between the afferent visceral and the efferent somatic sensations and concludes that there is a reverse process which causes visceral sensations resulting from irritation of the spinal nerves in the vicinity of the cord. He says, "This irritation may be due to a local myositis, osteo-arthritis . . . bony malformation at the nerve canals, or possibly direct pressure on these nerves due to the angle of curvature. In turn, because of the intimate relationship of the sympathetic network with that of the somatic nervous system, a motor reaction may occur in the innervated viscus," such as spasm, or a sensory reaction, as colicky pains or fullness. This may cause symptoms of gall-bladder disease, appendicitis, gastritis, colitis, etc. The author has found that active and especially young individuals are able to compensate for the spinal curvature, but, with the onset of fatigue and age, this diminishes and the "viscerospinal syndrome" appears. Five case histories are presented with symptoms of visceral disorders, apparent bronchial disturbances, and asthma, which have improved or disappeared upon partial correction of the spinal curvatures.—*Charles Lyle Hawk, M.D., Los Angeles, California.*

Zur Behandlung und Beurteilung des Wirbelbruches (Treatment and Evaluation of Cases with Fracture of the Spine). Carlos Schleipen. *Deutsche Ztschr. f. Chir.*, CCXXXVIII, 618, 1933.

Immobilization as the main treatment in cases of fracture of the spine is generally used in the first period following the trauma. The kind of treatment for use in the second period, when consolidation of the fracture has occurred, has been much discussed. One

group of surgeons apply corset or brace to take the weight off from the fractured spine. Another group, especially Magnus, is strictly against immobilization. They believe that when the first painful symptoms have subsided, massage of the spinal musculature should start (third day after injury); after four weeks patients are allowed to sit up in bed and after six weeks to walk around; active exercises of the musculature are substituted for the corset.

The author reexamined the fracture cases of the surgical clinic in Freiburg where, during the last ten years, different kinds of treatment have been used. He had 280 cases at his disposal; 186 were fractures of the bodies (in fifty-four cases more than one body were broken); twenty-four were total or partial dislocations; four were fracture dislocations; sixty-three cases were fractures of the transverse processes. The author found that it is not advisable to let a patient with a healing fracture of the spine walk around because secondary changes and deformities are very likely to occur. Therefore, he uses crawling exercises, beginning with the seventh week after the fracture. The use of braces and corsets is to be rejected because it not only weakens the musculature and the ligamentous structures, but also because it extends the treatment and the patients return to work much later than when treated functionally. Out of 109 cases from which good history and follow-up data could be obtained, only ten were without trouble, observation time being two years. All the other patients had pain at the fracture site, especially with the change of weather, and were less able to work than before the injury. Only twenty-three of the patients could work in the same capacity as before.—*Ernst Freund, M.D., Iowa City, Iowa.*

Spätresultate der Knorpelresektion bei Fissuraler Degeneration des Kniescheibenknorpels (Late Results of Resection of the Cartilage in Cases of Fissural Degeneration of the Joint Cartilage of the Patella). K. H. Erb. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 332, 1933.

The material of the Marburg Surgical Clinic from 1923–1927 was reexamined to prove Läwen's statement that by excision of the diseased cartilaginous area further development of an arthritis deformans can be delayed or even prevented. The author discusses briefly the etiology, diagnosis, and therapy. He believes that, despite all the symptoms mentioned in the literature, exact diagnosis can only be made after the knee joint is opened. Treatment should be surgical if long continued conservative measures are not followed by relief. Tourniquet is applied after blocking of the sciatic, femoral, obturator and the lateral femoral cutaneous nerves. Payr's S-shape incision is used. Motion is allowed very soon, at latest after one week. Eleven cases have been reexamined; seven patients answered questionnaires.

Altogether the results of resections of the degenerated patellar cartilage have been good. In no case have marked arthritic changes followed. Only small marginal exostoses at the patellar joint surface have formed in some cases. Besides the subjective feeling of improvement, the operation has prevented or delayed the further development of arthritic symptoms in four out of six cases which showed a deforming arthritis at the time of operation.—*Ernst Freund, M.D., Iowa City, Iowa.*

Anzeigestellung zur Behandlungsart der Pseudarthrosen der Langen Röhrenknochen (Indications for Treatment of Pseudoarthroses of the Long Bones). Hans May. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 184, 1933.

The author distinguishes four different groups of pseudarthroses and each of them has its special treatment of choice:

1. All the bone-forming tissues are preserved, especially the periosteum. Because of a lack of hyperaemia, no callus is formed, or, if callus is formed, it remains in a low stage of development. Roentgenogram shows no atrophy, but no callus formation; fracture space is narrow. *Treatment:* all the non-surgical methods,—as mobilization and friction of fragments, drilling (Beck's), injection of blood (Bier's) or natrium glycocoll

phosphate. The purpose of these methods is to provoke hyperaemia and proliferation of bone-producing tissues.

2. All the bone-forming tissues are preserved and active. Pseudarthrosis has occurred because of unsurmountable obstacles. Roentgenogram shows good callus formation, but no or insufficient bridging. The fracture space is wide. *Treatment:* Excision of obstructing tissues, freshening of the fragments, and apposition.

3. Periosteum partially destroyed or scarred. Interposition of soft tissues. Roentgenogram shows fragments well preserved, little callus formation or joint formation (Bier). *Treatment:* Splitting of fragments, transplantation of spongy bone (Matti) from the trochanter region.

4. Complete destruction of periosteum and bone defects. No callus formation. Interposition of soft tissues, resorption of the fragments. Roentgenogram shows atrophy of fragments, no callus formation. *Treatment:* Autoplastic bone graft.

One hundred and forty-eight cases of pseudarthrosis have been treated in Lexer's clinic in Munich during the last ten years. Seventy-one cases were of pseudarthrosis of the long bones. Ten were treated by bloodless methods, nine surgically without bone transplantation; in fifty-one cases an autoplastic bone graft was used; one case with double pseudarthrosis was fitted with a brace; and one case had an amputation because the skin over the pseudarthrosis was very bad. Out of the ten cases treated conservatively, in two, under an anaesthetic, the fragments were moved and rubbed. One was followed by bony union, the other had a bone graft later; there was interposition of the anterior tibial muscle. In two cases Beck's drilling was performed with good result. In three cases ossophyt was injected; in another three, callus extract; no result is given. Out of the nine cases treated surgically, but without bone graft, three were impacted; no result is given. In three cases the fragments were split after the operation; two showed bony union, one some motion. In three cases sequestra were found and removed; the bone ends were roughened. Good results.

Out of the fifty-one cases of pseudarthrosis treated with bone graft, forty cases were discharged as healed; six had a good result but were not completely solid. No follow-up. The other cases were failures.—*Ernst Freund, M.D., Iowa City, Iowa.*

Beobachtungen und Ergebnisse bei 400 Meniscusoperationen (Observations and Results of 400 Operations on the Meniscus). Felix Mandl. *Deutsche Ztschr. f. Chir.*, CCXXXIX, 580, 1933.

In the light of recent literature, the author made an analysis of 400 cases of operation on the meniscus.

The medial meniscus is subject to injuries for other reasons than purely anatomical peculiarities. The lateral meniscus is clearly more prone to "snapping knee" and to cysts.

The large majority of meniscus injuries are due to trauma. Of the author's series, forty-eight were non-traumatic. Degenerative changes are the principal factors; the rupture is secondary in importance.

From the history, the histological characteristics, and the bilateral involvement, the author proposed, years ago, his conception of the non-traumatic origin of rupture of the meniscus. According to this view, which seems to be confirmed by further observations and by reports in the literature, the cartilages of the knee degenerate as a result of excessive burden imposed upon them; this leads to the changes which have been described. These changes facilitate the production of a complete rupture following trauma.

The diagnosis is to be made clinically. Roentgenography with contrast materials is not satisfactory. In twenty-one cases the diagnosis was erroneous; in eleven of these arthrotomy, as such, was absolutely indicated.

Recommendation is made for "relatively early operation". There are few contra-indications. The author warns against operation in compensation cases or personal injury cases involving damage suits.

For the operation local anaesthesia is used (subcutaneous and intramuscular infiltration with forty to fifty cubic centimeters of one-half per cent. novocain solution, and intraarticular injection of forty cubic centimeters of one per cent. novocain).

The after-treatment consists of mobilization and massage as early as possible. Prevention of joint effusion has not been successful.

In all cases requiring subsequent arthrotomy, regeneration of the cartilage was ascertained.

A follow-up examination was possible in 338 cases in which operation had been performed eight months to ten years previously. Of these 272 (80.5 per cent.) were cured,—free from symptoms, performing heavy labor, or taking part in athletics; 35 (10 per cent.) were laborers or athletes, but still had symptoms occasionally; 16 (4.7 per cent.) were able to work, but not to engage in athletics; 15 (4.5 per cent.) were unchanged. None of the patients had an aggravation of their condition and all showed a primary healing of their incisions.—*R. J. Dittrich, M.D., Fort Scott, Kansas*

AN UNUSUAL DISEASE OF THE BONE MARROW (OSSEOMYELODYSPLASIA). Clifford G. Grulee, Carl W. Apfelbach, and Ralph E. LeMaster. *J. Am. Med. Assn.*, C, 162, 1933.

The author presents a new clinical syndrome that does not correspond to any known disease of the bone or bone marrow at this time. Myeloma, erythroblastoma, agranulocytosis, and several other diseases that produce similar clinical pictures were considered in the diagnosis, but were definitely ruled out by the observations and laboratory tests of the diagnostic study. He believes the disease to be a disturbance of the circulatory mechanism of the myeloid tissue.

The outstanding facts concerning this case are, briefly, a disease characterized by fever of an intermittent type, some joint symptoms, lack of much actual prostration, leukopenia, and a peculiar bone change throughout the course of the illness which was of a progressive nature. Successive roentgenograms showed a progressive thinning of the cortex of the bones and a corresponding increase in the size of the marrow cavity. In the vertebral column this thinning progressed to the stage where the vertebral bodies became so compressed as to cause cord pressure.

Autopsy on the patient showed grossly deformities of the vertebrae, ribs, and other bones which would occur from a softening of these bones and their consequent inability to oppose gravitational stresses and muscular tension. Section of the bones showed very thin cortex and markedly enlarged marrow spaces filled with a large, spongy, oedematous tissue. Microscopic examination of these bones showed the thinning of the cortex, the enlargement of the marrow, and within the marrow large, thin-walled, vascular spaces and multiple hemorrhages.—*H. E. Hipps, M.D., Dallas, Texas.*

THE USE OF THE DRINKER RESPIRATOR IN THE AFTER-CARE OF INFANTILE PARALYSIS. A. T. Legg. *J. Am. Med. Assn.*, C, 647, 1933.

The author calls attention to the fact that the mortality of infantile paralysis with involvement of the muscles has been brought down considerably by the use of the Drinker repirator, but that many of those who survive die a short time afterward with some lung disease, as a result of the diminished aeration, which they suffer. In many of these patients, following infantile paralysis with involvement of respiratory muscles and recovery, there results rather marked deformity in the thorax and chest, back, etc., due to paralysis, either bilateral or unilateral, of the chest and diaphragm.

The author uses the respirator as an exercisor for those patients who have so far recovered that they do not actually need it to preserve life. It prevents fatigue, however, in the muscles; produces chest expansion and breathing without muscular effort; prevents contractures in the paralyzed and strong muscles, so that chest deformity is prevented; increases aeration of the lungs and movement of the diaphragm and abdominal cavity;

and aids in the patient's general health. Considerable increase in the power of the paralyzed respiratory muscles has been noticed.—*Herbert E. Hipps, M.D., Dallas, Texas.*

PELLEGRINI-STIEDA'S DISEASE. A Report of One Case Surgically Treated. Jacob Kulowski. *J. Am. Med. Assn.*, C, 1014, 1933.

Pellegrini-Stieda's disease is characterized by semilunar-like bony formation in the region of the internal condyle of the femur and is always traumatic in origin. It has been described in foreign literature but this is the first case described in the English literature. The author gives a historical review of the condition with its onset and pathogenesis and reports a case on which he operated. In commenting upon this case he points out the similarity of this bony formation to myositis ossificans, and discusses the possibilities and probabilities of its origin.—*Herbert E. Hipps, M.D., Dallas, Texas.*

FRACTURES OF THE HUMERUS. Statistics and Treatment in Five Hundred Consecutive Cases. W. R. Cubbins and C. S. Scuderi. *J. Am. Med. Assn.*, C, 1576, 1933.

The authors present an exhaustive analysis of 500 consecutive cases with associated complications, types of treatments, and conclusions therefrom. The conclusions as presented by the authors are: Fractures of the upper two thirds of the humerus are most common in adults, while those of the lower third are more prominent in children. Open reduction was required in one out of every eighteen cases; non-union and delayed union occurred in one of every thirty-three cases. Radial paralysis, found in one of every thirty-four cases of fractured humerus and fractures of the surgical neck and shaft of the humerus, was best treated by primary immobilization of traction for from three to four weeks, secondary immobilization with Middledorpf's triangle and airplane splint for an elbow bandage for two weeks, a period of total immobilization for from six to seven weeks.

They found that fractures of the greater tuberosity did not require ninety degrees of abduction except in rare cases. Supracondylar fractures gave the best results if treated in maximum flexion and complete supination. They note that foreign bodies should be avoided as much as possible in open reductions and point out the value of preserving the posterior periosteum in open reduction of fractures of the shaft of the humerus, as it more adequately preserves the osteogenic property of the fracture site and is a definite mechanical aid in immobilizing the fracture.—*H. E. Hipps, M.D., Dallas, Texas.*

A BENIGN FORM OF OSTEOMYELITIS OF THE SPINE. A. DeF. Smith. *J. Am. Med. Assn.*, CI, 335, 1933.

The author calls attention to the usual form of osteomyelitis of the spine with very acute symptoms, high fever, marked prostration, frequently paralysis from spinal cord involvement, and a high mortality. He notes, however, that there is a type of osteomyelitis of the spine which comes on rather insidiously and may present no more symptoms than a simple ache in the back and is often disregarded because no more definite clinical symptoms or findings can be elicited.

In the fourteen cases which the author presents, eleven had a diagnosis of tuberculosis of the spine; but suspicion that the lesion was not a tuberculous infection was aroused by the facts that they followed pyogenic infections in other parts of the body, there was a productive bone reaction about the lesion, and a tendency for early bony ankylosis of the body. Laboratory proved that many showed high leukocytosis, and cultures of staphylococcus aureus were obtained in several cases directly from the bone.

He notes that conservative treatment has given the best results, because of the tendency to early fusion and that, where fusion is done in a definitely osteomyelitic spine, sinuses often develop which hinder and retard the patient's recovery.—*P. M. Girard, M.D., Dallas, Texas.*

SLIPPING OF THE EPIPHYSIS OF THE HEAD OF THE FEMUR. ITS RELATION TO RENAL RICKETS. J. F. Brailsford. *Lancet*, I, 16, 1933.

The writer describes the x-ray appearance of the upper end of the femur in the pre-slipping stage of slipped upper femoral epiphysis. There is some increase in the density of the metaphyseal periphery of the epiphysis, some increase in the metaphysis, in part or throughout its whole breadth, with some wooliness of the outline of the extremity of the diaphysis. These features should be sought for in children suffering from discomfort or pain in the hip joint. The recognition of these features should lead to measures designed to prevent slipping.

The writer is of the opinion that disease, weight-bearing and strain, and trauma all play a part in the production of this condition. There is some disorganization of the metaphysis which lessens its capacity to withstand the normal sheering stresses and strains, and the condition may be brought into prominence sooner by some trauma which would not have affected the normal femur. Further, he believes that renal rickets may produce such a disorganization of the metaphysis. Several cases of slipped epiphysis are presented which showed albumin in the urine (no chemical findings of the blood are presented). The x-ray appearance of bones showing renal rickets is characteristic and also the changes may be seen in only one joint. This characteristic appearance is a thickening of the metaphyseal area. Consolidation and repair of the metaphyseal tissue in renal rickets may be seen, by roentgenographic examination, to take place in as short a time as one month. Renal rickets should be excluded before any operative procedures are undertaken on these cases. The urine should be examined for albumin on several occasions in these cases.—*Robert Perlman, M.D., Iowa City, Iowa.*

SIGNS AND SYMPTOMS OF THE ACUTE STAGE OF ANTERIOR POLIOMYELITIS IN THE 1931–1932 EPIDEMIC. S. F. McDonald. *Med. J. Australia*, I, 1, 1933.

In the "dromedary" type, the initial stage, lasting two to six days, strongly resembles dengue fever, but without neck or spine rigidity. Unless an abortive case, after a few hours to several days, temperature again rises, there develops spinal rigidity, and paralysis may or may not occur. In the first stage the spinal fluid cells are usually absent; at the beginning of the second stage there are a few polynuclears, and, with the localization of the disease, the lymphocytes and mononuclears increase.

Roughly, the cell count was proportional to the severity of the infection. Lumbar puncture was considered justifiable in any child with fever, headache, prostration, stiff neck and back. It was always done under general anaesthesia; but was not done where the child was desperately ill or after paralysis had set in.

Muscle tenderness came only after the onset of paralysis. The greatest susceptibility was in the age group from two to six years; but the older children tend to be more seriously crippled, bearing out the view that paralysis is more severe in the more hard-worked muscles.

The fatal cases occurred in those of the overwhelming toxaemic type, and in the ascending Landry type. The cell count was high in the Landry type, low in the toxaemic, encephalitic type.—*Edward N. Reed, M.D., Santa Monica, California.*

A FEW NOTES ON THE SERUM TREATMENT OF ACUTE ANTERIOR POLIOMYELITIS. Alec E. Paterson. *Med. J. Australia*, I, 5, 1933.

The advised dose was fifty cubic centimeters, twenty cubic centimeters to be given intrathecally and thirty cubic centimeters intravenously. The serum was given to seventy-four patients and the results were "beyond all expectation". The author feels that had more serum been available, larger doses would have been given and even better results obtained. As to method of administration, the patient was anaesthetized and the serum given, (a) at body temperature, very slowly, through the spinal puncture needle *in situ*, an additional five cubic centimeters of spinal fluid having first been withdrawn, (b) intravenously by cutting down and exposing a vein in the forearm.

The serum produced a profound general reaction, as a rule, which was considered beneficial. The reaction began in about four hours and lasted about twelve. It produced, first, great misery, then a sudden change to comfort. The spinal rigidity required about six days for disappearance. The author believes that spinal puncture and spinal therapy had no causative effect on spinal rigidity.

Contrary to the belief that, once paralysis has set in, serum is useless, the author thinks that no matter to what extent paralysis is present, so long as the patient is febrile, serum is beneficial.—*Edward N. Reed, M.D. Santa Monica, California.*

EPIDEMIOLOGY OF ANTERIOR POLIOMYELITIS, WITH SPECIAL REFERENCE TO THE QUEENSLAND EPIDEMIC, 1931–32. J. Grahame Drew. *Med. J. Australia*, I, 26, 1933.

The epidemic included 299 cases, 127 in the metropolitan area and 172 in the country. The morbidity rate was thirty-nine and seven-tenths per 100,000 in the city and twenty-eight and six tenths in the country. Mortality rate was fourteen and sixty-eight one-hundredths per cent. The average age incidence was from one to five years in the city, and from two to seven years outside the city. The possible causes of such an epidemic are discussed.

It has been demonstrated that during the incubation period the disease is infectious. The infection can probably be carried by objects which have been contacted by patients or by carriers.

The author believes that strict quarantine of patients and of all contacts should be instituted immediately when an epidemic commences, and that schools should be closed.

Edward N. Reed, M.D., Santa Monica, California.

A REPORT OF THE EPIDEMIC OF POLIOMYELITIS IN NEW SOUTH WALES, 1931–1932. A. H. Tebbutt and Karen Helms. *Med. J. Australia*, I, 43, 1933.

The epidemic involved 435 cases. It began in the city of Sydney six weeks before it appeared in the country; about the same time-relationship between city and country as was observed in the New York epidemic of 1931. The mortality for Sydney was eleven and seven-tenths per cent., and for the whole state thirteen and one-tenth per cent.

After an exhaustive analysis, the author concluded that "a final statement cannot yet be made with regard to the rôle of convalescent serum therapy".—*Edward N. Reed, M.D., Santa Monica, California.*

THE RECENT EPIDEMIC OF POLIOMYELITIS FROM THE PHYSICIAN'S POINT OF VIEW. Edgar H. M. Stephen. *Med. J. Australia*, I, 60, 1933.

Poliomyelitis can be recognized in its preparalytic stage. Reliance may be placed on the examination of the cerebrospinal fluid. The average incubation period is six to sixteen days. The onset is usually gradual but may be sudden, with paralysis appearing within twenty-four hours, sometimes without fever; or of the dromedary type, the paralysis following the second hump. The stages are that of systemic invasion with pyrexia and sore throat; that of meningeal involvement, with meningismus; and the paralytic stage.

The spine sign is probably present in nearly all cases but may be evident for a few hours only. Apprehensiveness was a striking feature. Twitchings and tremors, retention of urine, and lack of uniformity of deep reflexes are suggestive of the preparalytic stage. Sore throat was present in about one-fourth of the cases. As to neck and spine, there is apt to be unwillingness for manipulation and there may be muscular tenderness, some rigidity,—the spine sign. Head retraction is uncommon. The spine acts as a rigid column.

As to convalescent serum, the author believes:

1. That convalescent serum is of definite value.

2. That, when certain nerve cells have been threatened, the use of serum has prevented complete destruction.

3. That, when destruction has already occurred, serum is valueless.—*Edward N. Reed, M.D., Santa Monica, California.*

ACUTE POLIOMYELITIS AS A PRIMARY DISEASE OF THE CENTRAL NERVOUS SYSTEM. A Reconsideration of the Pathology, Symptomatology, and Treatment, Based on the Hypothesis of Axonal Propagation of the Infective Agent. H. K. Faber. *Medicine*, XII, 83, 1933.

This is a very excellent review of the whole question of acute poliomyelitis and, as the title infers, the subject has been treated exhaustively. Probably the most outstanding feature of this discussion is the author's hypothesis of axonal propagation of the virus in humans.

With regard to the portal of entry, the author states, "We may accept without much hesitation, the olfactory mucous membrane as the most probable route of penetration of the virus of poliomyelitis from the surface into the central nervous system".

Symptomatology is fully discussed under the heading of the four phases: (1) symptoms at the beginning, (2) symptoms subsequent to the onset but preceding the appearance of paralysis, (3) symptoms present at the onset of paralysis, and (4) period of recovery.

The discussion of "the route of propagation of the virus" leads up to the various phenomena seen in the course of the disease: (a) halting cases, (b) abortive cases, (c) dromedary cases, (d) cases with advancing paralysis, (e) subclinical poliomyelitis, and (f) relapses and second attacks. This is followed by a discussion of the "Conditions Favoring Recovery".

In treatment, the need for "supplying the maximum concentration of antibodies in the blood at the earliest possible moment, and maintaining this concentration as long as is necessary" is stressed. In this connection the author concludes, "Intravenous injection of whole blood or serum in large amounts from donors tested for immunity, appears to be the best method at present generally available. Foreign serum of high antibody titer, when this can be supplied, may be still better."

An excellent bibliography is appended.—*Clarence A. Ryan, M.D., Vancouver, British Columbia.*

ROENTGENTHERAPY IN ARTHRITIS. New Aspects and Technic. Heinz Langer. *Radiology*, XX, 78, 1933.

Of the two great types of chronic arthritis, the atrophic type shows at first an inflammatory reaction of the bones in the joint regions, with little osteoporosis; later, decalcification, disappearance of joint cartilage and, finally, complete ankylosis. There is leukocytosis and shortened sedimentation time. There is always effusion into the joint, at first.

The hypertrophic type shows deformity of the bony contours, with spur formation; but not decalcification. This type may show metabolic disturbance, endocrine imbalance, or repeated mechanical trauma. "The result of strain and stress of life appears in some persons in the form of arthritis."

The roentgen diagnosis of arthritis should always distinguish between atrophic and hypertrophic; though both may at times be present in the same patient. Various experiments in treatment of arthritis by x-ray have been abandoned because of severe reaction with increase of pain.

The author, as the result of animal experimentation, believes that x-ray produces on the vegetative nervous system first stimulation and later sedation.

He states that the generally accepted conception today is that arthritis is an anaphylactic reaction to a bacterial infection. The vegetative nervous system plays an important rôle in anaphylaxis.

The author treated with x-ray arthritic patients who showed marked symptoms of vegetative nerve disturbance, treating the region of the corresponding ganglia and nerves, and also the involved joints. Physiotherapy, internal medication, and removal of focal infection were carried out simultaneously. The results in the case in which x-ray treatment was added to the usual routine were convincing as to the value of radiation. The author feels that both the higher ganglia and the involved joints should be irradiated. The technique is given in detail. Both types of arthritis responded. Seventy-five per cent. showed increased pain, lasting generally for forty-eight hours; while in twenty-eight per cent. of these increased pain with general malaise lasted from one to two weeks. This reaction was followed by subsidence of symptoms and marked improvement in seventy-five per cent. of the cases treated, with slight improvement only in twenty-five per cent. Several courses of irradiation may be necessary.—*Edward N. Reed, M.D., Santa Monica, California.*

Diagnosis and Roentgenologic Evidence in Spondylolisthesis. Henry W. Myerding. *Radiology*, XX, 108, 1933.

Recognition of this deformity probably averages less than ten per cent., but has increased rapidly since 1920. In the author's series of 207 cases, 64 per cent. were hard-working people; the average age was forty years, and seventy-one per cent. were men. Nine per cent. of the cases were symptomless. When the result of trauma, the condition may be acute and very severe. The principle complaint is backache, aggravated by stooping and lifting and relieved by rest, with associated pain in legs, thighs, and hips in thirty-six per cent. There may be weakness and numbness. The patient may appear well and be gaining in weight.

Congenital anomalies of fifth lumbar and first sacral vertebrae are frequent. Trauma, added to such a congenital condition, often inaugurates pain and disability. Anteroposterior roentgenograms fail to show lesser degrees; lateral views are most important.

The author classifies the lesion as grade 1, 2, 3, or 4, according as the fifth lumbar slips forward less than one-quarter, one-half, three-quarters, or more than three-quarters of the distance across the lumbosacral joint. The angle of the lumbosacral joint varies from normal to perpendicular and the fifth lumbar may lie entirely displaced in front of the sacrum, with its articular surface facing the anterior border of the sacrum. Separation of the neural arch is often seen. The sacral promontory may be lipped, or sheared off. In fifty-four per cent. the fifth lumbar was smaller and flattened behind.

Two per cent. of the cases were "reverse spondylolisthesis",—a backward slipping of spinal column and torso. These caused no marked deformity. In eighty-six per cent. the slip was between the fifth lumbar and sacrum, in eleven per cent. between the fourth and fifth; and in one per cent. between the third and fourth.

Detailed reports and roentgenograms of eight cases are presented.—*Edward N. Reed, M.D., Santa Monica, California.*

Atrophic and Hypertrophic Arthritis of the Spine. A. R. Shands, Jr., and M. O. Oates. *Southern Med. J.*, XXVI, 384, 1933.

This is an anlysis of cases seen at Duke University Hospital in the past two years. Excellent illustrations of types of arthritis of the spine are shown.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

Roger Anderson Apparatus in Fractures of the Lower Extremity. J. R. Bost. *Southern Med. J.*, XXVI, 507, 1933.

The author is very enthusiastic over the use of this apparatus, especially in fractures of the hip in elderly patients. Ten cases are reported.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

AN OPERATION FOR LATE REDUCTION OF THE SEMILUNAR BONE. E. D. McBride. *Southern Med. J.*, XXVI, 672, Aug. 1933.

It is claimed that reduction gives better results than removal of this bone. The author stresses the importance of suturing the dorsal horn of the semilunar to the posterior edge of the radius. An incision, one and one-half inches long, is made on the dorsum immediately to the lunar side of the extensor carpi radialis. The fibrous tissue in the bed formerly occupied by the semilunar is carefully removed, a curved periosteal elevator is passed forward to free the anterior horn from the anterior surface of the radius, the bone is then pried back into position by a Davis skid. If it cannot be reduced without too much trauma, an additional anterior incision is made down to the bone. Complete reduction is recognized by the contour of the dorsal horn. It is difficult to bore a hole in the bone, so a crevice is made in the anterior face of the dorsal horn, creating a hook into which a strand of No. 00 plain catgut is inserted and sutured to the dorsum of the radius. The hand is put up in dorsal flexion in plaster splints.—*F. G. Hodgson, M.D., Atlanta, Georgia.*

ÜBER "RENALE RACHITIS" UND "RENALEN ZWERGWUCHS" (Renal Rickets and Renal Dwarfism). H. Hamperl und K. Wallis. *Virchows Arch. f. Path. Anat.*, CCLXXXVIII, 119, 1933.

Report of two cases. Case 1, an eleven-year-old girl, proportionate dwarf (corresponding in size to a child six years and ten months old) died of chronic uraemia. Autopsy showed severe chronic interstitial nephritis of an unknown cause. Pathological changes in the bones were absent. Case 2, a girl, ten years and five months old, very small at birth, normal development until third year of life. Since the tenth year of life pain in the bones, difficulty in walking, dwarfism, size and proportion corresponding to a child of five and one-half years. Chronic nephritis with albuminuria. Roentgenograms show signs of a florid stage of late rickets. Autopsy showed interstitial chronic nephritis without inflammatory changes of the glomerulus and bone changes as in a severe florid stage of rickets.

A general discussion follows concerning the kidney and bone changes. It is possible that kidney lesions of a certain type lead to growth disturbance, dwarfism, with or without rachitic changes of the bones; but, contrary to common rickets, there is no hypophosphataemia, and usually there is hypocalcaemia. Specific antirachitic treatment seems to be without influence. On the basis of their two observations and of the study in the literature, the authors conclude that the metabolic disorder, provoked by the kidney lesion, may lead to the bone changes, but some unknown constitutional factor has to be present.—*Ernst Freund, M.D., Iowa City, Iowa.*

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